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# Compressed Air Magazine

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## JULY, 1923

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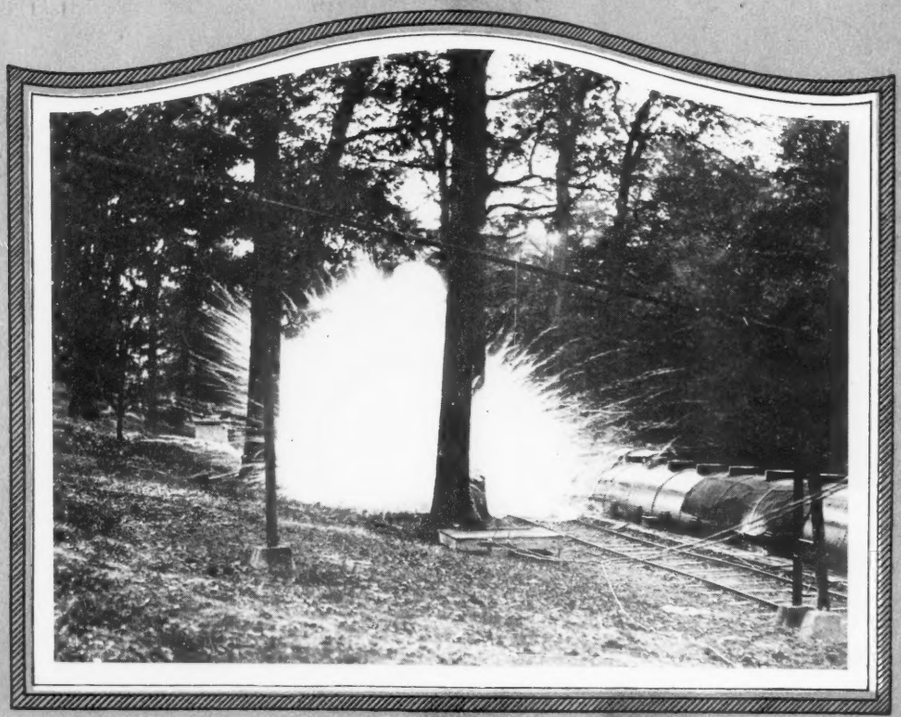

*UNITED STATES BUREAU OF MINES DEMONSTRATES AT BRUCETON, PA., THE EFFECTIVENESS OF LIQUID OXYGEN AS AN EXPLOSIVE.*

**Manufactured Ice Booms Nantucket's Increasing Activities**
Robert G. Skerrett

**The Great Broken Hill Mines in Australia**
H. H. Carroll and P. H. Warren

**Anchorage Foundations for Delaware River Bridge**
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**The Shandaken Tunnel Nearing Completion**
A. S. Taylor

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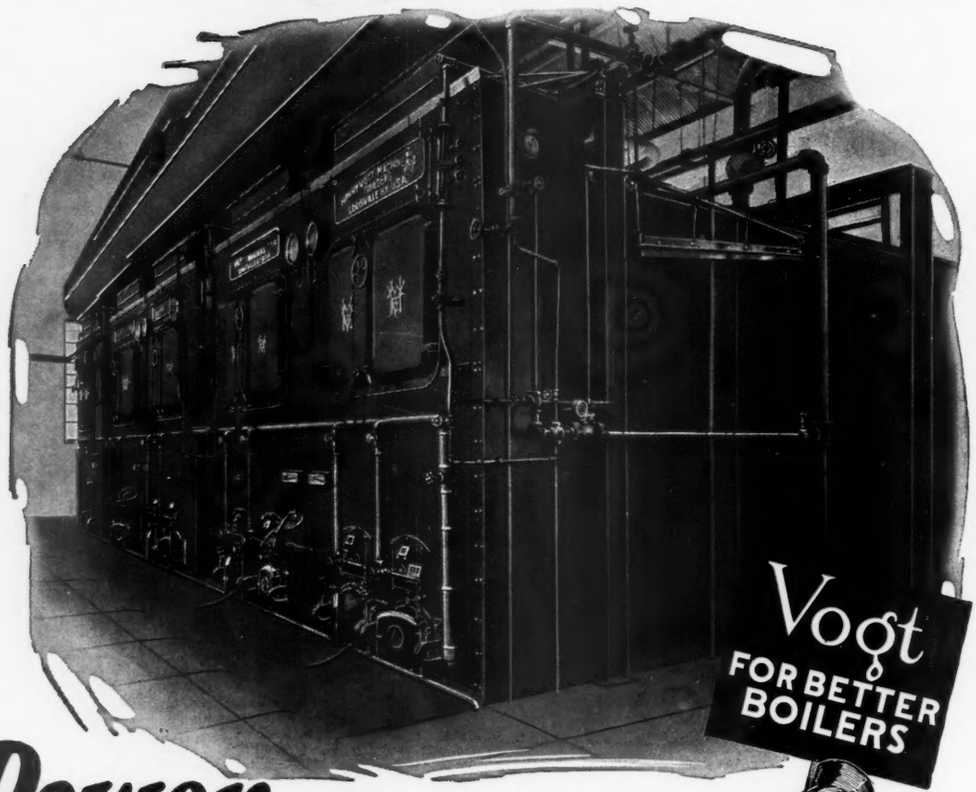


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*As a matter of reciprocal business courtesy help trace results*

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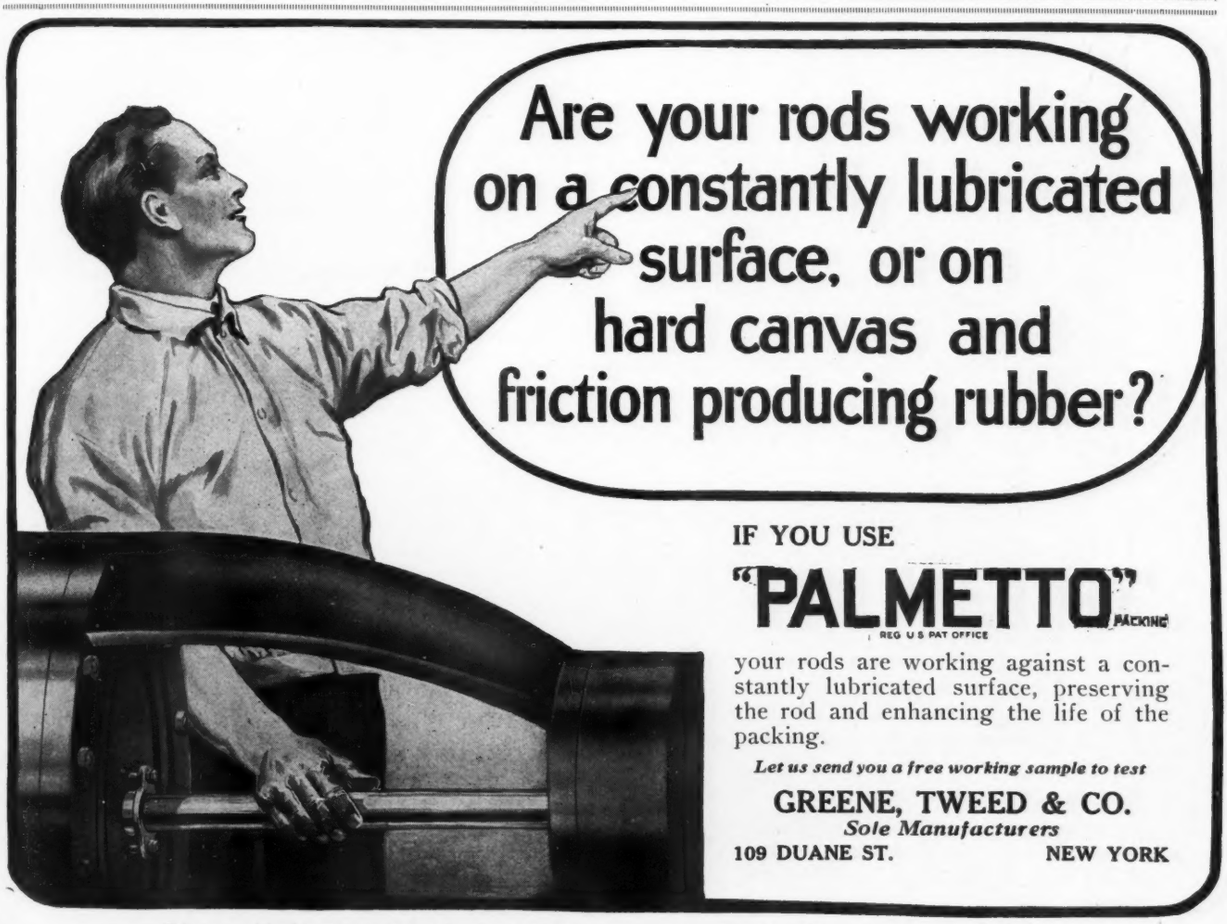
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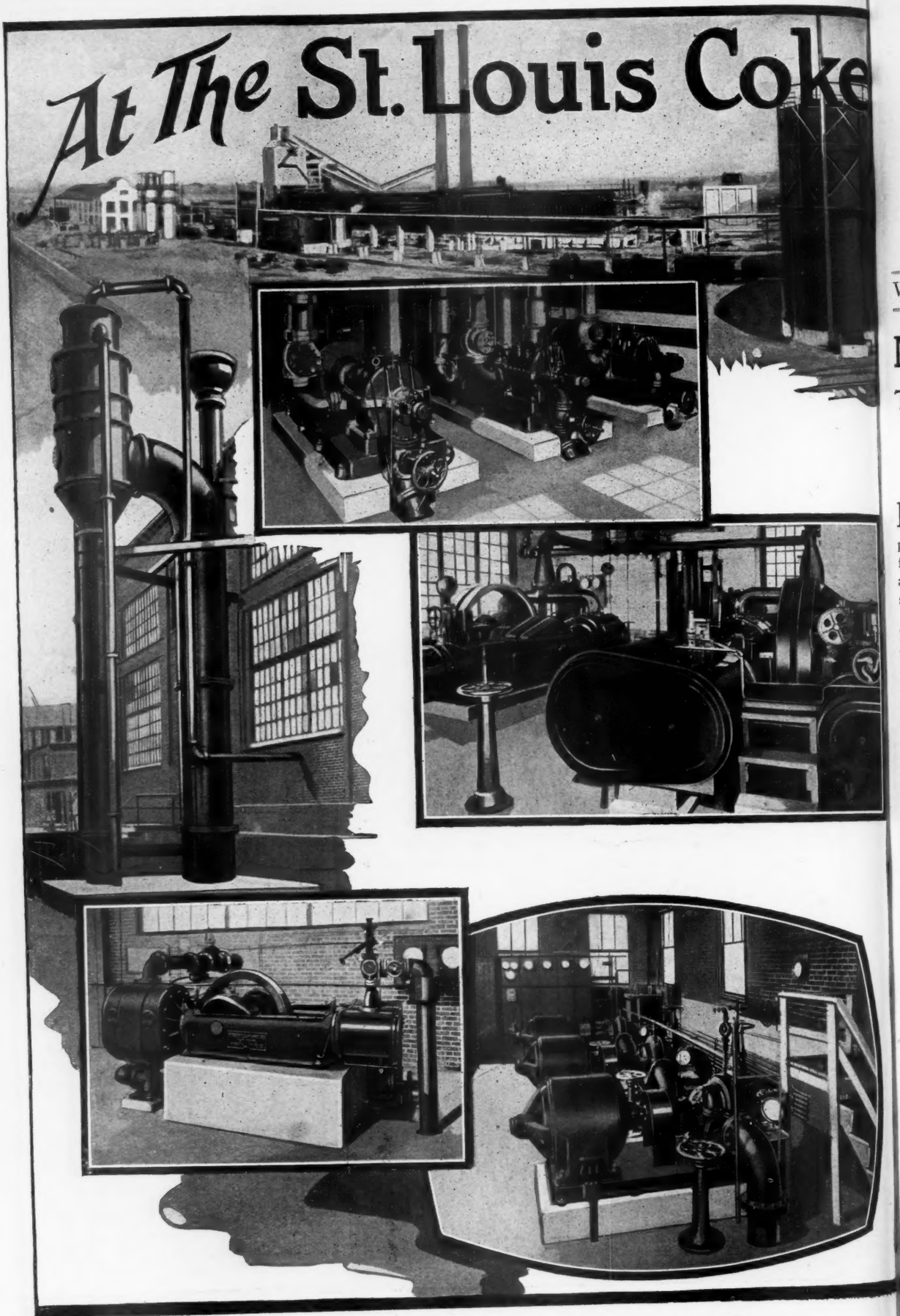


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JULY, 1923

# Manufactured Ice Booms Nantucket's Increasing Activities

## This Quaint Erstwhile Whaling Center Has Taken On a New Lease of Life and is Looking Up Both Industrially and as a Summer Haven of Varied Delights

BY ROBERT G. SKERRETT

IN THE DAYS when the whale furnished spermaceti for the best of our candles, pliant bone for a variety of purposes, and oil for many uses, Nantucket came into her own and assumed a conspicuous position among the so-called whaling ports of the United States.

As far back as 1673 the whaling industry had its start among the citizens of Nantucket, and in the course of a century her ships in this trade grew to a total of 150 craft, representing an aggregation of 14,867 tons. So much prosperity attended the pursuit of the great denizens of the deep that the town of Nantucket, by 1830, ranked third in commercial importance among the communities of Massachusetts. Her population in that year numbered 7,202 souls. Two years later, in the course of a twelvemonth, 40 vessels sailed from the island in quest of the sperm whale wherever it might be found within the Seven Seas. The industry reached its climax in 1842, when Nantucket had abroad in the whale fishery no fewer than 86 ships and barks, two brigs, and two schooners, having a combined capacity of 36,000 tons.

Whaling began to decline, as far as Nantucket was concerned, in 1843, and the island reflected this in various ways. From a population of almost 10,000 Nantucket's dwellers dwindled until they numbered less than 3,300 by 1890. The discovery of gold in California led to a large exodus in 1849 of the seafaring fraternity, making it very difficult to man ships; while the finding of oil in Pennsylvania a decade later and the maritime losses suffered during the Civil War gave whaling a blow from which it never recovered. Inasmuch as Nantucket's prosperity had hinged in the main upon the activity of her whaling fleet, the decadence of that source of wealth brought the island to its lowest ebb in 1870. The tide turned for the better, however, almost immediately afterwards when Nantucket began to win favor as a summer resort.

It was inevitable that a community which had won riches from the sea in days gone should again turn to the surrounding waters to yield it an income the year through; and while the fisheries now based upon Nantucket may lack the romantic touch of the whaling period still they play a prime part in the economic life of the island. The most important branch of this line of enterprise is that known as the flounder fleet; and it is this flotilla that catches the toothsome flatfish which so often makes a special appeal to the palate when served camouflaged as "filet of sole." Half of the success of the flounder fisherman is dependent upon keeping his catch fresh until he lands it on the dock at Nantucket for reshipment or until he can deliver the fish, himself, at the wharves of Fulton Market in New York City. Without an abundance of ice aboard his boat this would be impossible.

**NANTUCKET to most of us is but a name that carries us back to our school days when we were obliged to acquire a more or less intimate knowledge of America's geography. Relatively few of us are familiar with the industrial rise and fall of that lovely island which lies in the Atlantic about 30 miles off the southern coast of Cape Cod.**

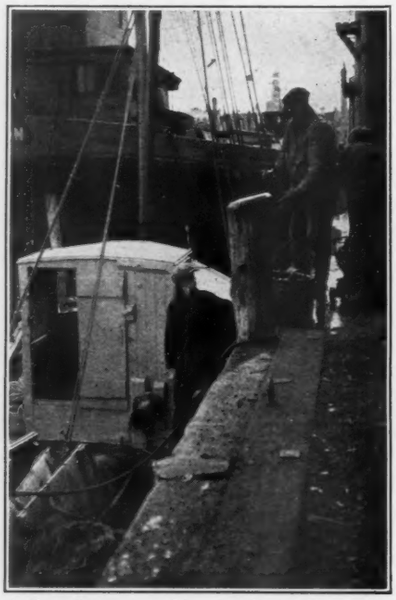
**During the past 25 years Nantucket has staged a "come back." This revival has caused the island to stand forth not only as a summer resort of many charms but as an important source of sea food for the nation's teeming Metropolis.**

**No small part of Nantucket's present-day business bustle is due to her fisheries; and the success of this field of enterprise, together with the comfort and satisfaction of her summer visitors, depends, undoubtedly, upon the availability of a plenty of ice. The accompanying story tells, among other things, what has been done recently to amplify the supply of this essential commodity.**

Before describing how the fishermen obtain their needful refrigerant at Nantucket, let us outline the composition of the flounder fleet and sketch the work done by it. For the most part, the flotilla is made up of sloop-rigged vessels, with a scattering of schooners, ranging in length from 50 to 60 feet. All of them have auxiliary engines which enable them to plug along when the breeze fails or when it is necessary for them to drive squarely into an opposing wind. During the summertime only about 30 of the boats pursue the flounder—the mackerel, the swordfish, and other warm-weather fry engaging the attention of the rest of the craft; but throughout the winter season the fleet is made up of from 80 to 90 vessels which center upon Nantucket and confine their efforts to the taking of the flounder.

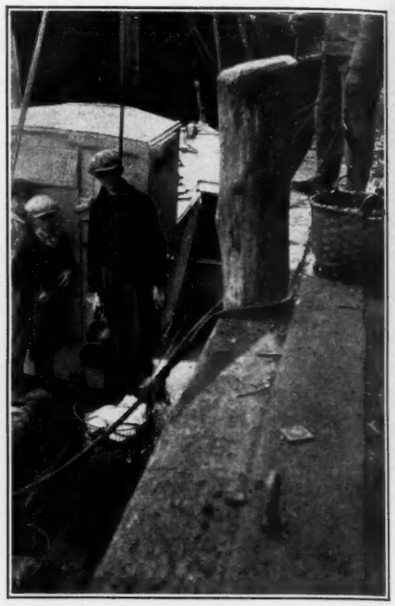
Small as they are, these sturdy boats are often called upon to battle with the Atlantic when the ocean is in a decidedly angry mood; and their crews not infrequently are forced to face hardships and hazards in harvesting a catch and in getting back to port. Normally, a flounder fisherman is away on a run anywhere from two to three days, depending upon the time required to make a profitable haul. In the winter months most of the fishermen restrict their operations to the waters extending from 20 to 50 miles eastward of Nantucket, from which they obtain flounders that are known as "pugs" or "black backs" and which weigh around three pounds apiece. They are forced to keep within this comparatively narrowed zone so that they can hasten back to port and shelter when stormy weather threatens.

With the coming of summer and milder conditions afloat, the flounder fleet ventures farther



*A flounderman making ready to ice up at Old South Wharf.*

*Throwing papers to the crew of Cross Rip Lightship.*



*A flounder fisherman discharging her toothsome cargo.*

seaward and does much of its fishing 110 miles offshore over Georges Bank, in water ranging from 20 to 24 fathoms in depth, where fish are caught which tip the scales at from seven to nine pounds. The larger of these bring a higher price because they can be marketed as "lemon sole." Last winter, the better grades brought seventeen and a half cents a pound on the dock at Nantucket; and the average price in the summertime is around twelve and a half cents a pound. In the course of a year 17,000 barrels of flounders, packed in ice, are shipped by steamer from Nantucket to New Bedford and thence dispatched to New York City; and a similar quantity, carried in ice in the holds of the craft, is delivered direct to Fulton Market. When the weather is warm, each barrel of flounders contains from 75 to 100 pounds of ice to insure the fish reaching the market in prime condition. Depending upon the season as well as the size of the vessel, a flounder fisherman before leaving Nantucket takes aboard anywhere from four to seven tons of ice.

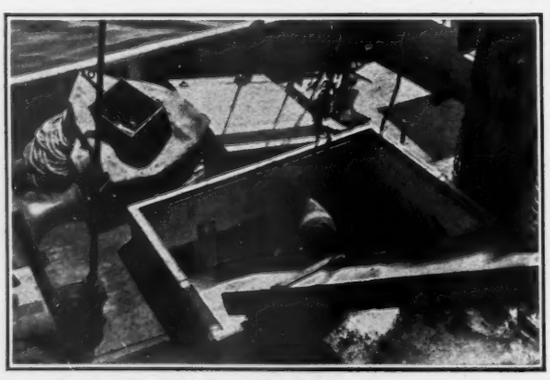
The hold of a flounderman is subdivided into a number of bins, all but one of which are filled with ground ice before she sails away. The empty compartment is the first one to receive any of the catch—ice being shoveled in upon the fish as they are brought aboard and placed below deck for keeping. Thus, successively, the ice is shifted and the different bins loaded with flounders and broken ice until the catch is big enough to warrant a return to port or the state of the weather compels this. Flounder fishing would be a doubtful venture without the availability of an ample supply of ice, because it is this refrigerant that preserves the fish while the cargo is accumulating—giving the men time to obtain a profitable haul—and enables the boats to carry their catch, fresh and toothsome, to a market.

To those unfamiliar with the subject, it might be of interest to learn how flatfish are caught. The flounder lives on or close to the water bed, and because of this a special form of seine has been devised to entrap him. What is known as an "auto trawl" is employed, which consists of a purselike net equipped with boards at the mouth that open out when the weighted contrivance is dragged along the sea floor. Thus, the bottom-hugging flounders are taken unawares and swept into the capacious maw of the trawl and held there until the net is hoisted to the surface and swung aboard the smack.

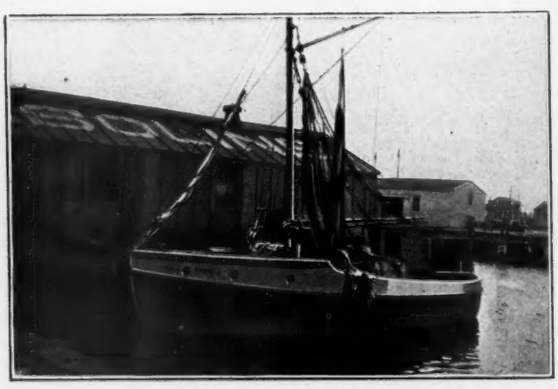
The focal point for most of the flounder fleet is Old South Wharf, originally built in 1760. There it is that the deep-sea fishermen bring in their fish so that they may be packed for reshipment to the Metropolis. The greater part of this work is done at night in order that the barrels of ice and fish may be ready to leave Nantucket by the early morning steamer. As might be expected, the ice is ground by machines which masticate the cakes rapidly. It is entirely practicable to grind ice and to load it into the hold of a boat at the rate of one ton every three minutes—seven 300-pound cakes representing a ton.

While our interest for the present is concerned principally with the activities of the flounder fleet, many of the boats constituting this flotilla, as we have previously mentioned, direct their energies in the summertime to the catching of mackerel, haddock, cod, and swordfish; and these, with some hundreds of barrels of eels, are also packed in ice and dispatched to Fulton Market. As may be realized, the operations of the fishermen and the business of the iceman are closely associated; and the dependence of the sea toilers upon the latter has grown steadily for a number of years.

Prior to 1902, when ice was first manufactured on the Island of Nantucket, what ice was available was harvested in the cold season

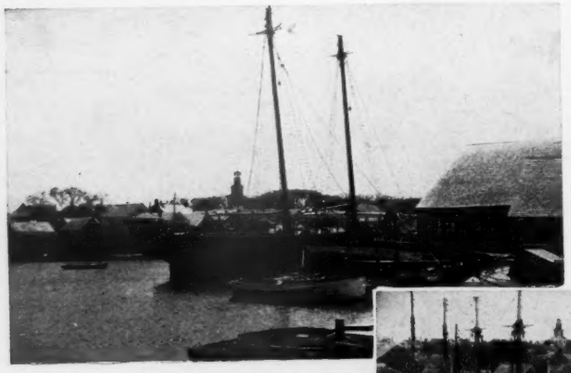


*A flounder fisherman loading with ice preparatory to sailing.*



*A typical flounder fisherman with its seine aloft for drying.*

*Fig. 1—The low-level, multi-jet condenser connected with the steam exhaust of the new ammonia compressor. Fig. 2—A portion of the engine room of the ice plant showing the Putman machine which is the prime mover for the old ammonia compressor. Fig. 3—The two boilers of the power plant of the Island Service Company of Nantucket, Mass. Fig. 4—The 6x5-inch Ingersoll-Rand compressor which furnishes air for operating the air hoist in the tank room. Fig. 5—The recently installed "Imperial" type XPV-3-A ammonia compressor of 75 tons refrigerating capacity.*



*Looking townward from the waterfront.*

*Where pleasure craft winter on the harbor shore.*

*A glimpse of the picturesque waterfront of Nantucket.*

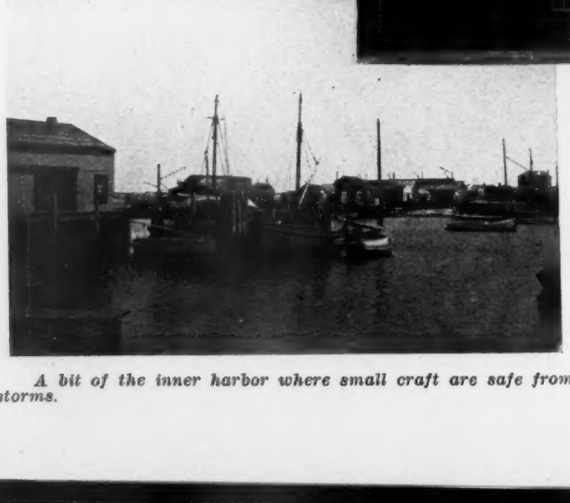
from local ponds or came from the rivers "Down East." For one reason or another, the supply of ice from those sources occasionally turned out to be insufficient, undesirable, or too high priced. These conditions led to the erection of an ice-manufacturing plant in the town 21 years ago—that installation, as was then the general practice, being equipped to produce distilled-water ice. In those days a belief prevailed that it was not possible to make hygienic ice unless the water was first distilled in an effort to free it of any lurking germs and other impurities. As a matter of fact, the state of the art was such that distilled water had to be used to insure clear ice. Had "raw water" been employed with the facilities then relied upon the ice would have been white or snowy and not equal to natural ice in its refrigerating and keeping qualities.

The making of distilled-water ice is not economical when fuel has to be brought from afar and is, for transportational reasons, expensive. The cost of essential coal must, inevitably, be reflected in the market value of the ice manufactured thereby. The primary reason, as just explained, for the use of distilled water was to obtain clear instead of white ice. Ordinary or raw water contains a quantity of air held in solution, and by boiling and distilling the water this air is expelled so that substantially none remains to form bubbles during the freezing period. When bubbles form within a cake the ice has a snowlike appearance.

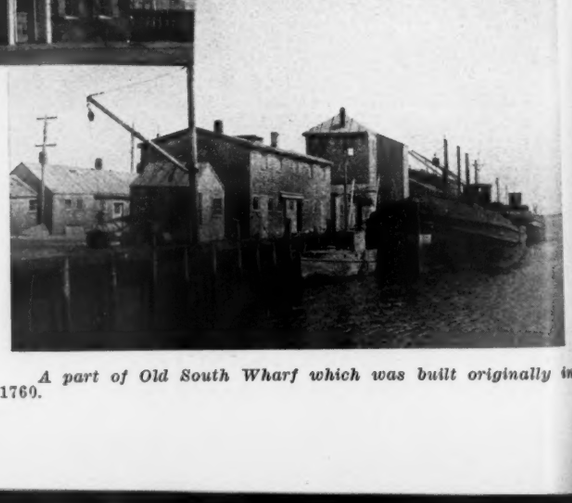
Now distilled water for an ice plant is obtained by condensing exhaust steam which has already done work in an engine. It is, therefore, no unusual thing for distilled water from such a source to contain organic matter, carried over from the boiler, as well as a trace of oil. This explains why the core of a cake of distilled-water ice is often found to emit a disagreeable and even a decidedly foul odor. But, apart from these aspects of the subject, the average distilled-water ice plant is uneconomical owing to operative losses which need not be entered into here inasmuch as they are well known to refrigerating engineers. We have purposely dwelt upon this phase of ice making so that it would be plain why the Island Service Company adopted the raw-water system when it established its plant at Nantucket in 1917.

In that year, the Island Service Company purchased historic Old South Wharf, and erected an ice manufactory at the shore end of that pier within easy reach of the fishing fleet. The undertaking was recognized as somewhat of a venture; but capable handling and an unfailing effort to please brought deserved recognition and a steadily increasing demand for the plant's output. During the past two or three years both the fishing fleet and the populace generally have called for more and more ice, and the Island Service Company's equipment has been run to capacity through the summer months. Lacking reserve machinery, a breakdown in the warm season would have proved a serious inconvenience, if not a calamity, to the community; and, alive to its obligation to the public, the company decided some months ago to amplify its resources to a marked extent. The new facilities are now in place and ready to meet not only the demands of Nantucket, with its summer population of 15,000, but to provide a surplus which can readily be disposed of in the towns of neighboring Marthas Vineyard.

*One of the first of Nantucket's spermaceti-candle factories.*



*A bit of the inner harbor where small craft are safe from storms.*



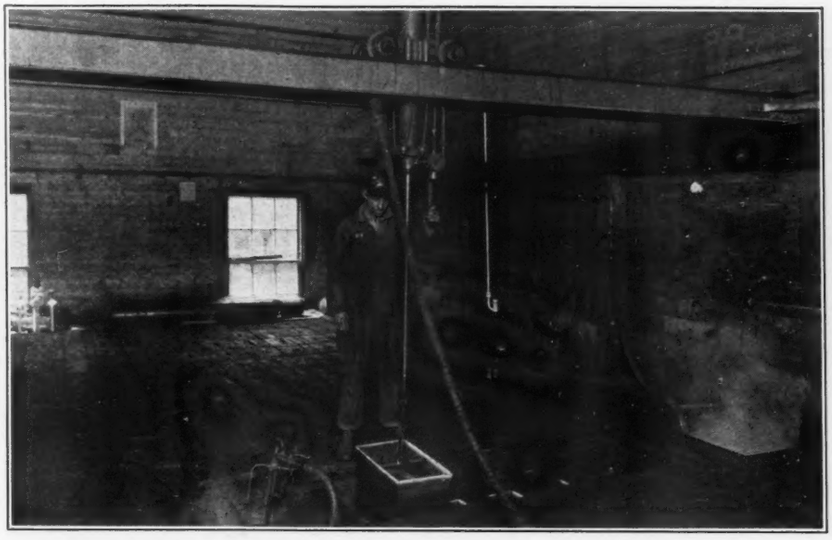
*A part of Old South Wharf which was built originally in 1760.*

Up to the present year, the ice-making plant of the Island Service Company has consisted primarily of a duplex vertical York compressor having a daily refrigerating capacity of 40 tons. This belt-driven unit is actuated by a 115-H.P. horizontal, single-cylinder steam engine designed originally as a demonstrating engine for Harvard University. It was built by the Putman Machine Company of Fitchburg, Mass., about four decades ago. This fact is interesting evidence of the care exercised in the design and the construction of the machine, because it is still performing well. Steam is supplied by two Dillon boilers rated, respectively, at 90 H.P. and 108 H.P., and operating at a pressure ranging from 100 to 125 pounds. The boiler of larger capacity was added last year.

The adjacent ice tank, which is 60 feet long and 20 feet wide, has a capacity of approximately 65 tons, being equipped with 432 cans each capable of producing a 300-pound cake of ice. Inasmuch as it requires 48 hours to freeze the water in a can, the maximum actual output is one-half that of the total capacity of a tank. However, it has been found feasible with the York ammonia compressor to produce an average of 22 tons of ice in the course of 24 hours. This would have fallen far short of the peak demands had the machine not been worked during slack periods so as to turn out an excess of ice to be held in reserve in the storage room which can accommodate 300 tons. Even so, there have been occasions during the warm months when the market was larger than the supply; and this situation prompted the management of the Island Service Company to take steps to increase the size of its ice-making equipment.

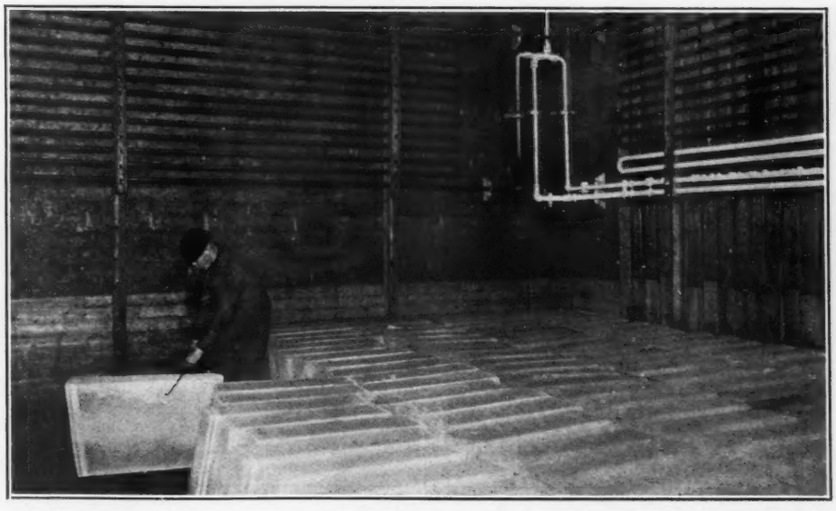
Before describing the new machine which has recently been put in place, let us explain broadly the manner in which a raw-water ice plant works. The water used by the Island Service Company is drawn from the town main, and, therefore, is not "flat" like distilled water or tainted with oil or with organic matter derived from an unclean boiler. But to make clear ice from raw water, the water must be agitated during the freezing period to get rid of the air bubbles formed at that time and which would otherwise be held in the ice. Paradoxically, air is employed to send these gathering bubbles surfaceward—compressed air being utilized for this service. Compressed air is led through small tubes to the bottoms of the cans where it is discharged, and in rising through the water the streams of this air sweep the forming surfaces of ice free of any clinging bubbles. Thus, the water freezes, assumes its normal crystalline structure, and is not rendered opaque by the presence of entrained air. One of our illustrations shows the agitation of the water in two cans during the freezing process.

As a result of this latter-day development, raw water, with all its desirable "live" qualities, can be used in the manufacture of an ice which is often decidedly superior to that of Nature's making. Ice so produced by man can be put directly into refreshing drinks without the risk of impairing their palatability. The agitating air at the plant of the Island Service Company is furnished by a small rotary



*Pneumatic lift pulling cans filled with ice from the tank. The hot well at the right loosens the ice so it can be discharged by the dump.*

*Jets of compressed air agitating the raw water in two cans during the freezing period in the ice tank. The covers are temporarily removed.*



*A corner of the ice storage room which has a capacity of 300 tons. Only the white coils at the right are for the time being filled with refrigerant.*

compressor which is run continuously—the air entering the water at a pressure of two pounds.

In the ice tank, the cans can be pulled at the rate of one a minute when working to capacity; and this operation is speeded up by an air hoist mounted upon a traveling overhead crane. Air for this hoist is drawn from a receiver which is charged to a pressure of 90 pounds by a 6x5-inch, belt-driven, Ingersoll-Rand compressor. This compressor is run only intermittently; and air from the same source is utilized for various purposes, among which is the blowing up of automobile tires. And now for a description of the recently added equipment which not only augments the capacity of the plant but makes it feasible to operate the establishment much more economically.

*Old South Wharf, the property of the Island Service Company, viewed from the roof of the associate ice-manufacturing plant.*

Fundamentally, the improvement consists of an Ingersoll-Rand duplex, 2-stage ammonia compressor, steam-driven, with compound steam cylinders. The high and the low-pressure ammonia cylinders are, respectively, 8½ inches and 12 inches in diameter, while the steam cylinders are 11 and 18 inches in diameter—the stroke for both the steam and the ammonia cylinders being fourteen inches. This machine is equipped with a water intercooler between the ammonia cylinders, and is provided with a low-level, multi-jet condenser to deal with the exhaust of the steam cylinders. In short, the compressor and its associate features are designed with a view to a high degree of efficiency in combination with fuel saving. The unit will be capable of producing 50 tons of ice daily—more than doubling the previous performance of the old outfit, which will be retained as a reserve.

Inasmuch as the isolated position of the Island Service plant on Nantucket is akin to that of many other ice-making plants located where fuel is at a premium and where great care has to be exercised to show a balance on the right side of the ledger, it will not be out of place here to emphasize the virtues of some of the features which characterize the XPV-3-A ammonia machine. Tests have proved conclusively the advantages and economy of 2-stage compression of ammonia gas as compared with the single-stage system heretofore extensively employed. Further, investigations have revealed that 2-stage compressors are equally suited for ice making or for cold-storage service. "Inlet heating" of the ammonia gas is 50 per cent. lower in the case of the 2-stage compressor than with the single-stage unit. This reduction of "inlet heating" increases, accordingly, the refrigerating work accomplished by the unit upon a given expenditure of fuel or power.

Where cold water is obtainable, the use of a water intercooler to lower the temperature of the gas passing from the low to the high-pressure cylinder leads to a material saving in power. With a 2-stage compressor, the intercooler can be employed whenever the saving in power warrants it. Depending upon the operating circumstances, the temperature of the cooling water, and the condition of the ammonia at the intake, the saving in question will vary anywhere from two to eight per cent. of the total power required. The management of a plant can readily determine whether or not this economy is worth while.

Recognizing the steadily increasing tendency towards recourse to high steam pressures and superheat, the builders of the machine in question brought out eleven years ago a steam-driven compressor equipped with balanced piston steam valves; and experience since has demonstrated that this type of valve construction is especially suited to compressor service. With a valve of this character any commercial steam pressure or degree of superheat can be used, as well as ordinary saturated steam. The next improvement in this type of steam-driven compressor was an automatic cut-off governor operated by means of oil pressure. This governor varies the steam cut-off agreeably to any change in the admission or the exhaust pressure, or in the ammonia suction or discharge pressure, and maintains a constant speed. In short, these several developments contribute, each in its own way, to higher and better performance while lowering the cost of the service rendered.

## A PNEUMATIC ACCELERATOR

A PNEUMATIC throttle-control device has been brought out by the Motor Products Corporation, replacing the customary accelerator pedal. It employs compressed air in place of the usual rigid metal connection between the foot and the carbureter. On pressing a bulb, the air pressure is transmitted to a cushion and thence to the carburter. An increase of foot pressure causes the cushion to expand. This movement controls the action of a rod leading to the carbureter, but does not interfere with the hand throttle.

It is claimed that the pneumatic accelerator prevents the gasoline from being fed too rapidly, and tends to eliminate the choking and the bucking of the engine. The fluctuations in the carbureter control, resulting from the jolting and the bouncing of the foot, are done away with. The location of the rubber bulb may be changed to suit the convenience of the driver.

According to the seventh semi-annual survey just completed by the Bureau of Mines, the quality of gasoline marketed in the United States is getting better day by day.

*An architectural monument to the prosperity of the whaling days of Nantucket.*

*Looking west on Main Street with its overarching elms which were planted in 1851.*

# Gunite Stops Leaks in a Water-Supply Reservoir

BY IVAN E. HOUK

*Spraying gunite by air around the foot of a column at a pressure of 60 pounds to the square inch. The small hose feeds water to the nozzle just before the sand and the cement are expelled.*

*Pneumatic chipping hammers were used to open up all cracks and joints right down to solid concrete before applying the gunite which has served to arrest seepage.*

STOPPING leaks in concrete water-supply reservoirs, where the head is 30 feet or more, is not an easy matter if ordinary concreting methods are employed. It is very difficult to place new concrete on old concrete in such a manner as to secure a satisfactory bond even when the old surfaces are chipped out to a considerable depth. Repairs made in that way are seldom permanent: it is generally necessary to follow them up, sooner or later, by coating the whole reservoir with some waterproofing compound, or by placing an entirely new concrete lining—either of these courses being comparatively expensive. However, since the development of the cement gun the stopping of reservoir leakage has been somewhat simplified.

The accompanying photographs illustrate work recently done with the cement gun in Dayton, Ohio, in arresting leakage in a 10,000,000-gallon reservoir. This reservoir was built in the summer of 1921 by a local contractor, under a cost-plus arrangement, at an outlay of approximately $210,000. It is located on a gravel foundation, at the top of a high hill near the south edge of the city; is octagonal in shape; and has an inside diameter of 280 feet, a side length of 116 feet, and a depth which decreases from approximately 30 feet in the center to about 13 feet at the sides. The roof slab is supported by 145 columns, each two feet square, spaced twenty feet apart. The floor slab rests on the gravel foundation, and on the footings at the bases of the columns. Expansion joints an inch thick, made of poured asphalt, were placed every 40 feet in each direction.

Considerable leakage occurred from the time the reservoir was completed and put in service until the cement-gun repairs were made. The water seemed to escape by way of the expansion joints around the columns and in the floor as well as through small contraction cracks in the floor and the walls. The pressure of the water apparently pushed the asphalt through the joints and into the gravel below. The contractor attempted to stop the leaks thus brought about by refilling the joints with asphalt and by placing concrete collars around the bases of the columns; but this work, due to failure to obtain a proper bond with the old concrete, did not result in materially reducing the leakage. This spring, when the reservoir was emptied for its annual cleaning, it was decided to try gunite.

First, the collars were removed from the bases of the columns where there were signs of leakage, and, next, the joints and the cracks were thoroughly dug out down to solid concrete by the aid of three pneumatic chipping hammers operating at a pressure of 75 pounds per square inch. Some of the openings around the column footings were so large that water, poured into them from a pail, seeped away as fast as it could be put in. Then all openings were filled with gunite, applied at a pressure of 60 pounds per square inch. The gunite was permitted to set for ten days before any water was discharged into the reservoir. The cement gun, the associate portable compressor, and the other necessary equipment were located on top of the reservoir near a manhole, and the air line, attached to the gun, was led through this manhole down to the various parts of the reservoir that needed attention.

*The cement gun delivering gunite through a manhole into the reservoir during the work of stopping leaks in the floor of the structure. One of the smaller lines furnished compressed air for the operation of pneumatic tools.*

Before the work of overhauling was done the reservoir leaked at a rate of approximately 10.75 inches per day, equivalent to about 440,000 gallons. After the gunite was placed the wastage did not exceed 2.75 inches per day, a reduction of almost 75 per cent. Apparently, there are still a few cracks which were overlooked, but it is not believed that any of the joints filled by the cement gun are now leaking. The repairs cost less than $1,500, while to have coated the entire reservoir with a waterproofing compound would have amounted to more than twelve times that much. In view of the fact that the expense of pumping water to the reservoir is about $16.41 per 1,000,000 gallons, the actual money loss to the city, due to leakage, was reduced from about $3,000 per annum to somewhere around $750.

The work was carried out by the City of Dayton under the supervision of the Division of Water and the Bureau of Sewer Maintenance—the cement gun being the property of the latter. George F. Baker, Director of Public Service, W. W. Morehouse, Superintendent of Waterworks, and Joe Madigan, Superintendent of Sewer Maintenance, were directly in charge of operations.

## MULTIPLE-SERVICE TRUCK FOR ROAD UP-KEEP

*By R. F. MUNDORFF*

OUR HIGHWAYS, as a means of country-wide communication, are becoming more and more important to the pleasure seeker, the traveler, and the transporter of goods and materials of an endless variety. In short, our highways, within certain limits, are competing with the established steam and electric common carriers. Because of this trend, it is essential that these roadways shall, in the first place, be well built and, in the second place, be maintained in a manner to facilitate the safe and the efficient movement of vehicular traffic. The following description tells what has been done to this end in one of our western states.

To keep its roads in proper condition, the Highway and Road Building Departments of Kern County, Cal., maintain a motor truck that is outfitted with an air compressor and with a complete line of the pneumatic tools that have been found so adaptable for the quick repair of highways. Power for the compressor is transmitted by belt from the forward end of the driving shaft; and a receiver is located just back of the cab on the right side of the truck. Air is supplied by a 6x6-inch, 2-cylinder machine at 80 pounds pressure.

"Jackhamers" are used to break up the concrete wherever the road is damaged and has to be fixed, and chippers, also pneumatically operated, are employed to chip out cracks. Jets of air are utilized to blow away broken material and to clean out fissures preparatory to filling them with concrete. As most of us know, concrete batches are different for different jobs, and a certain quantity of broken stone is always carried on the self-contained truck. However, the mobile plant is provided with pneumatic drills of various sizes so that, among other things, more rock can be drilled and blasted to furnish enough material for the needs of the work in hand.

The truck is equipped with combination bins and a rotary concrete mixer which is driven by an auxiliary shaft from the transmission. The bins are constructed of steel, and have a capacity of 1,600 pounds of cement, 1 cubic yard of sand, and 2 cubic yards of gravel or rock. The material is fed by gravity, and is controlled by hand-operated gates loading into the mixing apron. In order to protect the cement from moisture, the compartment in which it is kept is fitted with a steel cover.

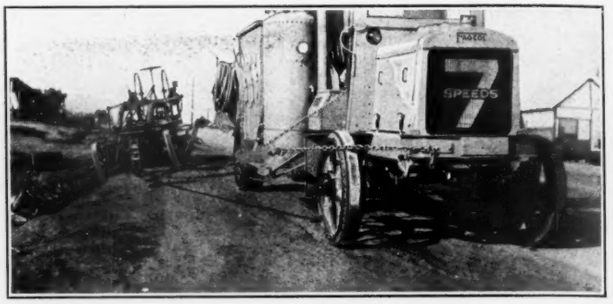
Between the bins and the mixer is a 150-gallon steel tank for water, and this is withdrawn for use by gravity or by air pressure, as desired. For filling the tank from convenient wells or streams a centrifugal pump, with a self-priming device and a suction pipe is utilized. The concrete is placed either directly from the mixer or is conveyed to the point where repairs are being made by a large steel wheelbarrow carried on the rear of the truck. The outfit also includes an asphalt heater; and when small breaks, especially in the shoulder of the road, are discovered it is but a few minutes' work to pour the asphalt; to make a hot patch; and to continue on to the next job.

In one section of the country where the truck was used it was necessary to erect twenty miles of fencing where there was considerable hard-pan. By means of the air-operated post-hole digger it was possible to dig 379 holes, to a depth of two feet, in seven hours. On mountain roads it is often needful to cut away a portion of a wall or hillside where it has shown a tendency to wash down upon the roadbed; and the "Jackhamers," etc., provided for just such contingencies, dispose very quickly of work of this nature. Where washouts or other obstacles call for blasting, the air drills are brought into play to drill the holes for the dynamite. Again, in many places, it is essential to paint or to repaint bridges and other highway structural features, and for that purpose the truck is outfitted with a paint-spraying apparatus. And, what is quite as important, the compressor is always right there to furnish the power to operate these various tools.

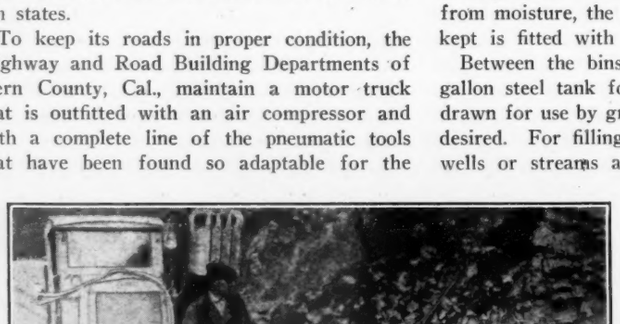
It has been estimated by Mr. Stanley Abel, Supervisor of the Highway and Road Building Departments of Kern County, that with the road-maintenance truck and its diversified compressed-air equipment an average saving of from $70 to $93 per day has been realized as compared with the system formerly employed. This saving is directly attributable to the rapidity with which the work is accomplished by the use of pneumatic tools.

The facility with which this self-contained power and repair plant can be moved from point to point and made to do its work economically renders it feasible to live up to the road-builder's slogan: "The time to begin to maintain a highway is the day it is opened for traffic."

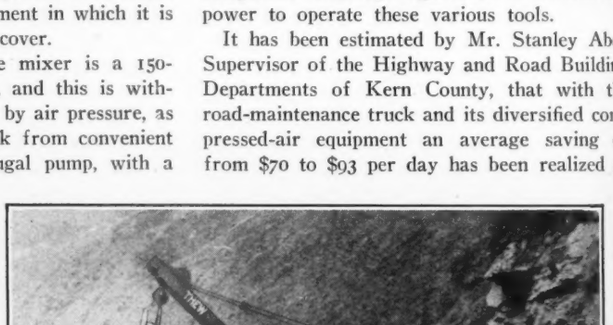
*Ingersoll-Rand drill employed in the novel service of boring holes for the erection of fence posts.*




*In this case the highway maintenance truck is serving as a tractor for the road-scraping machine.*



*Pneumatically operated "Jackhamer" drilling holes for the quarrying of rock to be used in the construction of a highway.*



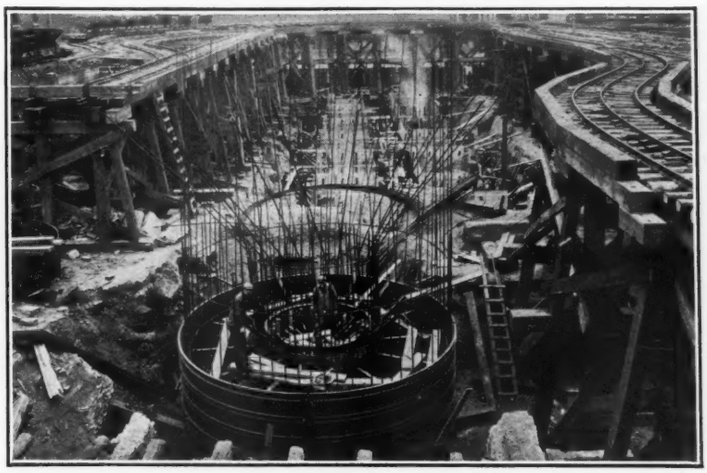
*"Jackhamer," operated by compressed air from the truck, drilling holes for blasting out rock in widening a roadway.*

# Anchorage Foundations for the Delaware River Bridge

## Description of Methods Employed in Sinking the Rectangular and the Circular Caissons to Bedrock

BY S. G. ROBERTS

MOST OF THE activity at present apparent in Philadelphia and Camden in connection with the great Delaware River Bridge has to do with the sinking of caissons for the cable anchorages. This, as may be readily grasped, constitutes an important engineering task, because upon the security of these anchorages will ultimately depend the stability of the span which is to reach across the river highway a distance of 1,750 feet, from tower to tower.



*A partial view of activities at the anchorage site on the Philadelphia side of the river. The foundation for this anchorage covers an area of two-thirds of an acre.*

The cables, from which the deck of the bridge will be suspended, are of unprecedented size, and their weight, together with that of the span roadways, must be largely borne by the opposing anchorages at each end of the structure. A bit of the history of bridge building will help us to a realization of the magnitude of the new undertaking. When Roebling designed the Brooklyn Bridge, which was opened for service in May of 1883, he decided to employ four steel cables each 15¾ inches in diameter, satisfied that nothing less would answer to hold safely aloft a span of such unapproached magnitude.

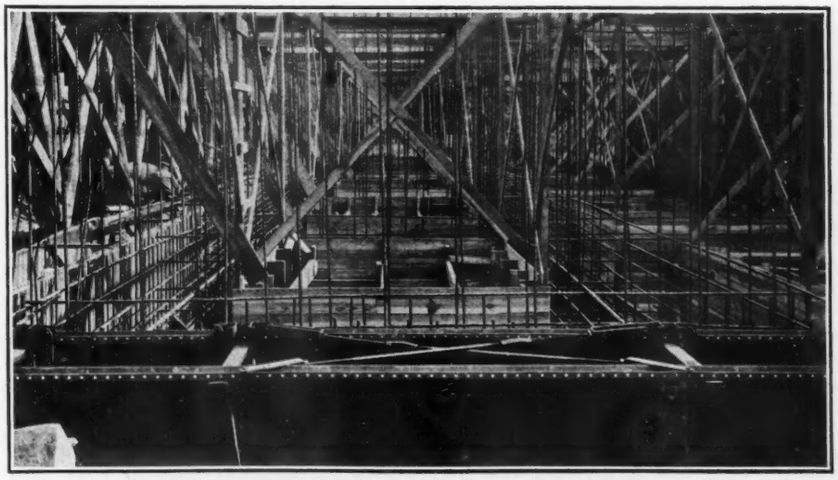
It will also be recalled that reliance in four cables was similarly placed in the case of the two succeeding bridges thrown across the East River, but in view of the loads to be carried the cables were made considerably larger—those of the Williamsburg Bridge being 18⅝ inches in diameter and those of the Manhattan Bridge being 20½ inches in diameter. Mr. Ralph Modjeski, as Chairman of the Board of Engineers of the Delaware River Bridge Joint Commission, determined, for good and sufficient reasons, to adopt a two-cable design, and this involved a further increase in cable diameter in order to provide ample strength to sustain a loaded deck measuring from side to side a matter of 125½ feet. Each of these cables will have a diameter of 30 inches and be composed of 61 strands of wire 0.192 inch in diameter, made of high-carbon steel, galvanized to guard against corrosion. These 61 strands will be bound together and wrapped with serving wire so as to form a complete cable.

The cables are to be held aloft by steel towers—one on each side of the waterway—rising to a height of substantially 380 feet above the surface of the river; and, by way of a departure in practice, these cables will be securely fastened to the tops of the towers. Therefore, any longitudinal movement due either to a changing load upon the bridge or to the flexing of the towers will be distributed directly or indirectly to the anchorages. It must be borne in mind that the towers, under the influence of the sun, will be intermittently warped from the perpendicular; and the effects of temperature changes will, in this wise, bring into play varying stresses upon the cable anchorages.

As we have tried to make plain, the purpose of the anchorages is to hold the ends of the cables firmly against the maximum pull to which these aggregations of wires may be subjected. Inasmuch as it is not practicable to embed the cables or their anchor chains in solid rock, the engineers will make use of a mass of masonry in the form of an anchorage that will have sufficient weight and be so attached to the underlying ledge that there will be no possible chance of slippage. This, in short, is what is now being constructed inshore on each side of river.

To quote from a report made last December by Mr. Modjeski and his associate engineers: "In working out the design for the foundations of these two anchorages, various methods and forms of construction were considered. The adopted design consists of two rectangular and eight circular caissons for each anchorage. These will be built of reinforced concrete and sunk to bedrock by open dredging methods. The rectangular caissons are each 125 feet in length by 40 feet in width for the Philadelphia anchorage and 140 feet in length by 40 feet in width for the Camden anchorage. The circular caissons are all 20 feet in diameter. It is expected that the caissons will be founded at a depth of 65 feet below high water on the Philadelphia side and 95 feet below high water on the Camden side.

"The function of these foundations is to transmit to rock the vertical weight of the anchorage and the horizontal pull of the cables. On account of their greater horizontal stiffness, the rectangular caissons will take practically all of the horizontal pull, while the vertical load will be carried by both the rectangular and the circular caissons." The rectangular caissons underlie the riverward section of the anchorages while the circular caissons, disposed of in two transverse rows, are located beneath the inshore section of each anchorage structure. For the sake of brevity, the present article will describe the procedure followed in



*A close-up of a rectangular caisson illustrating the extensive and complicated arrangement of the steel-reinforcing bars.*

constructing and sinking the caissons at only one of the anchorage sites—that on the Philadelphia shore.

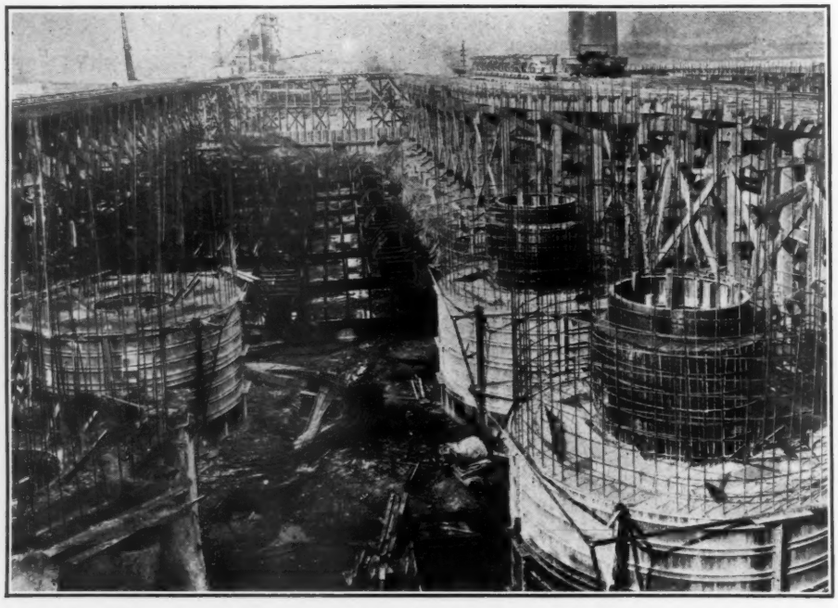
The circular caissons have been picturesquely described as "glorified piles" by the chief engineer in the field at the Philadelphia point of operations. This is not an inappropriate term, because these caissons have an outside diameter of 20 feet and lengths of 60 and 69½ feet, depending upon their positions. The caissons of the same type at the Camden anchorage are 91½ feet long. As previously mentioned, the sinking of the caissons has been carried out up to date by open-dredging methods which have for the time being obviated the employment of compressed air. Nevertheless, an Ingersoll-Rand compressor is held continually in readiness to supply air in case of emergency.

The Philadelphia anchorage site is located upon made ground—the original shore line of the Delaware ran a little to the westward, and the buildings that occupied the present area rested upon heavy timber cribbing and piles steadied by an earth fill. In excavating the initial pits for the various caissons, a good deal of old timber and numerous large-sized rocks were encountered which greatly hampered the work of the orange-peel buckets relied upon to do the major part of the digging. The excavating was begun on the 16th of last October and was pushed successfully despite the obstacles mentioned so that the entire pit for the south rectangular caisson was leveled by November 22 to Elevation —9.0 feet. Then, cinders, to a depth of one foot, were spread in the excavation preparatory to placing blocking on the ground for the temporary support of the heavy steelwork of the cutting edge. With the cutting edge assembled, the blocking was removed about a week later, and the cutting edge of the south caisson was then lowered onto the cinder bed at Elevation —8.5 feet prior to pouring the first of the associate superposed concrete.

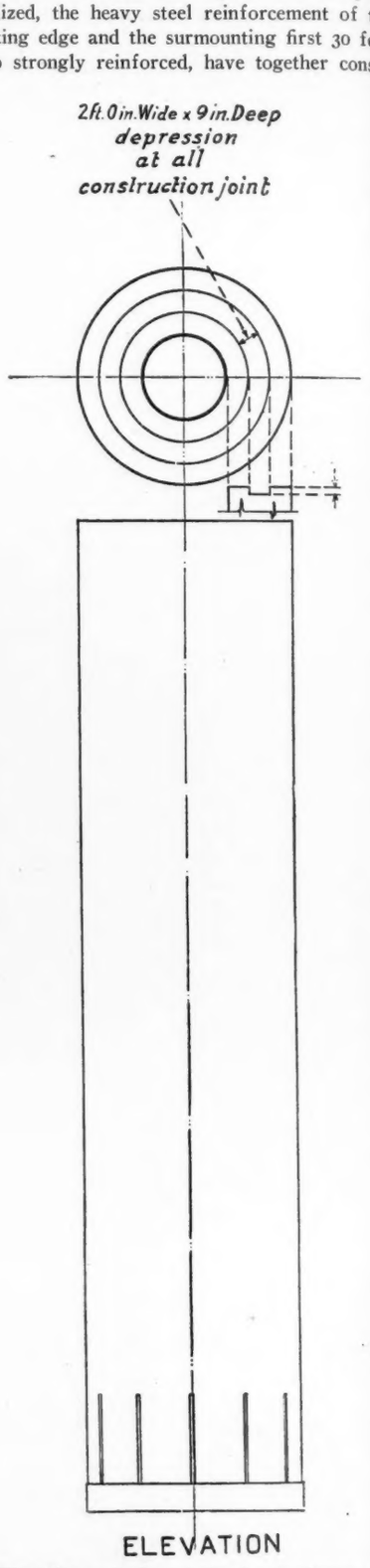
Each rectangular caisson is pierced vertically by twelve dredging wells which are arranged symmetrically in two longitudinal rows so that excavating can be carried on anywhere beneath the caisson within the area covered by it. The wells are also rectangular in cross section, and measure throughout the greater part of their vertical shafts 10x11 feet 4 inches. The walls which surround the enlarged chambers at the bottoms of the wells spread downward, and they are thus made to taper and to form a series of cutting edges, reinforced with steel, which supplement the main cutting edge underlying the four exterior caisson walls.

When the dredge buckets remove earth from the center of a well chamber, the weight of the caisson tends to force the neighboring cutting edges downward and to cause the soil to move inward and into the excavation made by dredging. In other words, the buckets are able to dispose of dirt which otherwise would be beyond their reach. It should be understood that none of the mucking is done by hand, in fact could not be done manually owing to the fact that the cutting edges descended below the ground-water level shortly after they began to settle toward their goal—bedrock. The circular caissons have circular dredging wells which terminate at the bottom in steel-faced cutting edges; and the dredging procedure is substantially like that followed in the case of the rectangular caissons save that operations are conducted through a single well in each circular caisson.

To return to the work done on the southern rectangular caisson, which has been sunk more rapidly than its northern neighbor, the first 30 feet was poured and allowed to season for 28 days before sinking was started on February 16 of the current year. Wooden forms were used for the inside work and Blaw-Knox metal forms for the exterior of the caisson. The first ten feet of the caisson was cast in three sections—the initial lift being four feet high and the two succeeding lifts three feet high each. Since then, additional 10-foot lifts have been made in three pours. As may be realized, the heavy steel reinforcement of the cutting edge and the surmounting first 30 feet, also strongly reinforced, have together constituted a basic concrete girder of great strength. When finished, the maximum height of the rectangular caissons will be 60 feet from contact with bedrock to Elevation —5 feet. Every 10-foot lift represents a volume of 1,140 cubic



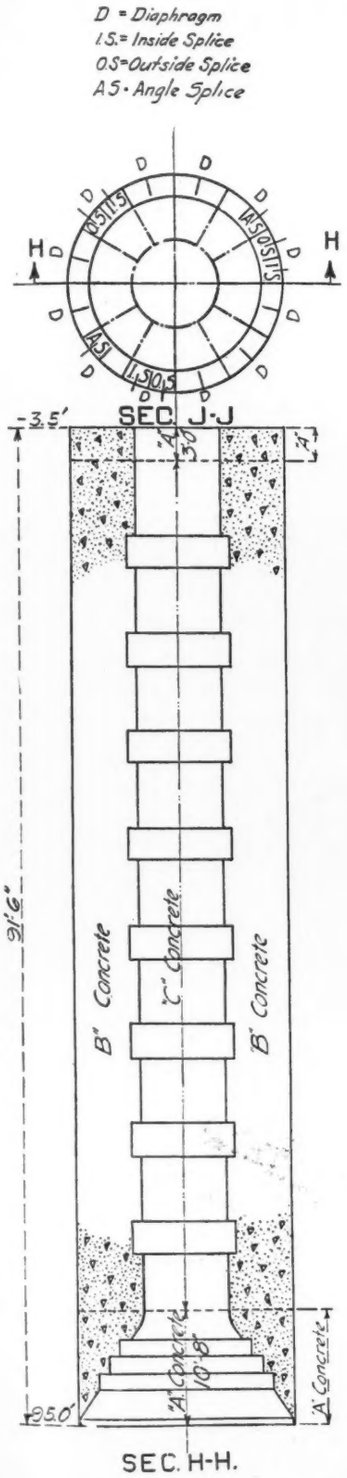
*General view of one of the anchorage sites showing the first of the steel work for a rectangular caisson and circular caissons in various stages of construction.*




*Elevation and plan of circular anchorage caissons.*

yards; and contiguous lifts are bound together by keys.

Sinking was started by hand trenching in the center pockets of the caisson and continued until the first few inches of settlement were obtained, after which the supporting struts in the end pockets were removed. Much study was given to the subject of how best to sustain the cutting edge and the initial lifts before transferring the load directly onto the bed of ashes in the pit; and at one time it was thought that the substructure would have to be somewhat complex. This idea was abandoned because it was self-evident that many difficulties would be encountered in removing the falsework so as to leave the cutting edges free. The problem was solved by adopting a simple arrangement of struts which could be got rid of with comparative ease when the sinking was begun.




*Vertical section and plan of circular anchorage caissons.*

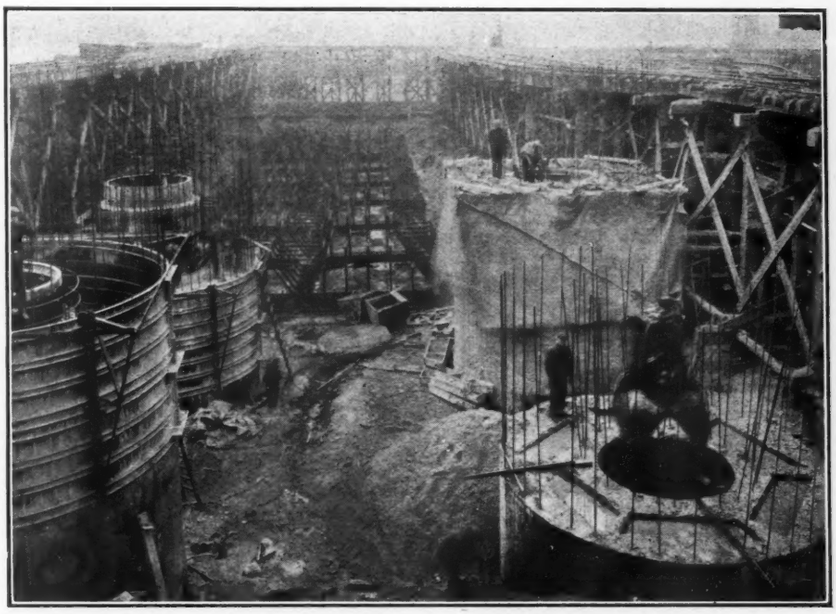
It is rather fortunate that no serious obstacles have been encountered since the sinking of any of the caissons began. The nearest approach to trouble occurred in sinking Circular Caisson No. 2 when it had been poured to a height of 30 feet. Settlement was obstructed by a boulder having a volume of about one cubic yard, but as soon as this was disposed of the caisson promptly penetrated a matter of eighteen inches.

For the most part, the underlying soil has been found to be sand, gravel, and clay holding occasional boulders ranging in size from that of a man's head to half a cubic yard in volume. The orange-peel buckets have been able to deal with these effectually.

Since March, the sinking of the various caissons has gone forward without a hitch, although a slight upward deflection of .12 foot and a downward deflection of .13 foot developed in the north rectangular caisson early in April. This was corrected as soon as digging was carefully directed at the right points, and the field engineer's report states: "Since that time there has been little difficulty in maintaining the plane of the cutting edge within less than a few hundredths of a foot of a plane surface."

Should any serious obstruction lie in the path of a descending caisson this may be dealt with in two ways. Either a diver could be sent down into the dredging well concerned to drill and to blast the arresting body or that well could be sealed *pro tem* with a bulkhead carrying an air-lock so that sand hogs could enter the working chamber so formed and take the necessary steps to get rid of the impeding mass. When the several caissons have settled to their respective depths and are in contact with the solid ledge, the bedrock will be cleaned by divers preparatory to binding the caissons to this foundation by filling the dredging wells with concrete. In this work, of course, compressed air will be an essential aid.

After the two rectangular and the eight circular caissons have become fixed and transformed into so many reinforced-concrete monoliths, there will be placed upon them a single great reinforced-concrete slab ranging in depth from 14½ feet to 68 feet. This will complete the foundation and the main mass of the anchorage to which the western ends of the cables will be linked by eye bars or so-called chains, which, in their turn, will be suitably locked to steel girders embedded in the base of the anchorage.



*The work of pouring and sinking the caissons was carried on throughout the winter, canvas coverings and salamanders being used to protect the concrete from frost.*

As might be expected, the removal of old buildings and the clearing away of ancient foundations and filling have brought to light a number of interesting tokens of the early days of the City of Brotherly Love. For instance, the long-buried hulk of a sailing craft loaded with coral ballast was unearthed during the digging of the pit for the north rectangular caisson. British pennies dating before the Declaration of Independence were also found; and among other things the excavators recovered cannon balls and the hammered-copper badge of a Colonial policeman. In a house that stood on the southwest edge of the anchorage site Ben Franklin's mother lived; and there is reason to believe that the very building in which the field engineers have their office was once a warehouse belonging to Stephen Girard, that doughty Quaker, who did so much to make the Port of Philadelphia famous in the generations gone.

## AIR DRILLS AND HAMMERS TESTED BY SPECIAL DEVICE

THERE HAS been developed at the shops of the Pittsburgh & Lake Erie Railroad, at McKees Rocks, Pa., a special air-motor testing device for the purpose of making comparisons between different types of pneumatic drills and pneumatic hammers having about the same capacity and size.

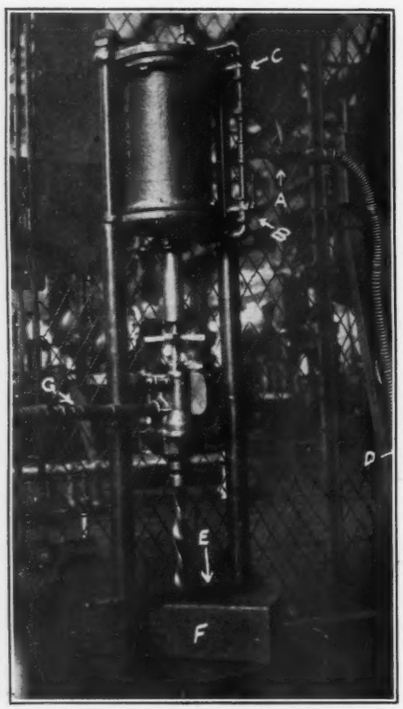
In the case of the pneumatic drill, those in charge of the tests believe that through this method it is possible to get a fairly accurate comparison between the capacities of the different makes of this tool by noting the pressure on top of the drill, the number of revolutions per unit of time, and the depth of the hole drilled per unit of time. The pressure on top of the machine can be increased to a point where it will stall the drill, and the amount of this pressure is recorded.

For testing drills, a motor is mounted in the device, as shown in one of our illustrations, and is guided at the drill by a crossbar, E, resting on a test block, F. Air is supplied to the cylinder through flexible hose, D, and valve A. Valves B and C are 3-way cocks, and are so arranged that when B is closed and C is open, for example, air is admitted at the top of the cylinder and exhausted at the bottom. This forces the piston down on top of the air motor at a pressure indicated by the gage. The extent of this pressure may be regulated as desired. Air is supplied to the motor by means of another hose, G, on the left; and after the test is over the motor can be released by closing valve C and opening valve B. There is a pressure of approximately 100 pounds on the shop line.

For testing, the air motor is set up with a 2-inch drill point resting on test block F, and pressure is applied slowly until the air motor is pulling to capacity. The revolutions per minute are counted, and the pressure is noted. The pressure needed to stall the motor is also recorded, and, provided the sharpness of the drill point is kept constant, this pressure is the measure of the efficiency of the air motor. If the motor does not come up to requirements it is overhauled and the difficulty corrected. Through this test it is practicable to determine whether or not a drill, after being repaired, has been brought back to the rated capacity of the tool when new.

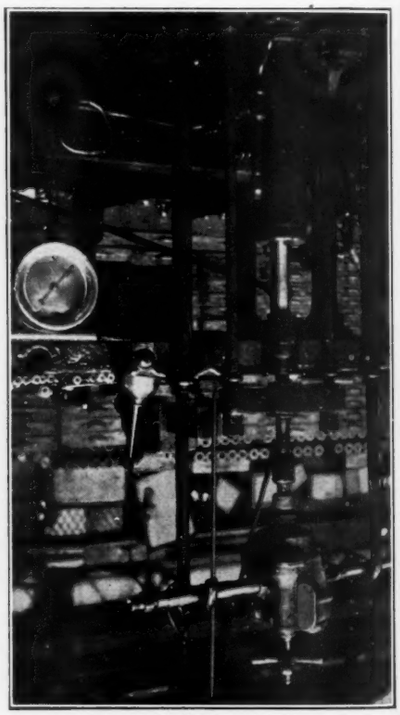
In ascertaining the vibrations of hammers, the piston rod of the 8x14-inch air cylinder of the testing machine is chalked, and the vibrations are indicated by a pair of calipers held against the piston rod. The hammer is allowed to run for a given length of time, and the vibrations are measured. This test is run to make comparisons between different types of new hammers, and it is also applied, when old hammers are being overhauled, in order to find out if the vibrations have increased to any extent with the age of the pneumatic tools.

D. J. Redding, assistant superintendent of motive power of the Pittsburgh & Lake Erie Railroad, reports that some of the hammers which were said to have the least vibration have shown excessive vibration under this kind of test. He is considering modifying the machine in question to such an extent that it will be able to make comparative capacity tests of hammers. It is believed that this can readily be done by the aid of additional attachments.




*Drill testing device which makes it possible to determine the operating power of a drill's air motor.*

*The testing device adapted for the measurement of the vibration of new or repaired pneumatic hammers.*



*A modification of the foregoing equipment which permits the drill to be differently suspended during testing.*

## NIAGARA TO HELP DRIVE NEW ENGLAND

The New England Power Company develops large hydraulic units on the Connecticut River and its tributaries, and is distributing 115,000 kilowatts for manufacturing purposes. It is in touch with the steam power stations in the big New England cities so that in time of low water its service may not be interrupted. Transmission lines are being run to connect the Adirondack Power Company of New York with the New England system on the east and with the Niagara system on the west—delivery of power is promised for 1924.

## SIZE OF SAND-BLAST SAND

The sizes of sand best adapted for the different uses of the sand blast have never been authoritatively determined. A prominent sand producer, who caters to the foundry trade, suggests the following: Sand which passes a screen with a 0.17-inch mesh and is rejected by a 0.15-inch mesh is recommended for cleaning steel castings. Sand which passes a 0.15-inch mesh and is rejected by a 0.084 inch mesh is best for steel and heavy gray-iron castings, and sand passing a 0.084-inch mesh and rejected by a 0.043-inch mesh is recommended for sanitary ware, stove plate, and light gray-iron castings.

## A SELF-CONTAINED ELECTRIC TRAIN

The electric car or train is now one of our most familiar servants, but the self-contained, electrically propelled train is still somewhat of a novelty. Such a train is being operated experimentally in the neighborhood of Johannesburg, South Africa. It uses a hitherto worthless combustible—the "char" or ash from locomotives that is being thrown on the waste pile. The power car carries its own gas-generating plant and internal combustion engine driving a dynamo, which, in turn, furnishes current for the tractor motors. A speed of twenty miles per hour was attained.

# The Great Broken Hill Mines In Australia

## Practice Followed in Working the Famous Deposits of Silver, Lead, and Zinc

## PART I

BY H. H. CARROLL AND P. H. WARREN*

THE GREAT Broken Hill silver, lead, and zinc mines of Australia are situated in the extreme western section of New South Wales. The City of Broken Hill is 340 miles from Port Adelaide and 225 miles from Port Pirie, both in South Australia, where the lead-silver concentrates are smelted.

A 3½-foot-gage railway connects with Port Pirie, but, on the journey to Port Adelaide, there is a change in the gage to 5¼ feet at Terowie, 195 miles from Broken Hill. Ultimately, a standard-gage railway line, at present partly finished, will connect Broken Hill with Sydney, 826 miles distant.

Silver was first found 47 years ago in the district at a place named Thackaringa, about twenty miles from Broken Hill. From that time on until 1883, when the great Broken Hill lode was unearthed, a large number of small lodes of the fissure and the gash types were operated in the neighborhood. These mines were worked to a depth of approximately 100 feet, and produced very rich silver ores including cerargyrite and embolite. The discovery of the lode completely overshadowed the smaller mines, and ever since then Broken Hill has been the center of all mining activity in the region.

The mineral field is situated in the low-lying Barrier Ranges, which are about 1,000 feet above sea level. The surrounding country is devoted to the grazing industry; but, while much of the soil is rich and fertile, the climatic conditions are extremely dry—the average rainfall being only eight inches per year—so that sheep and cattle raising has a very precarious tenure. The mining industry directly supports a population of 30,000 people in the City of Broken Hill.

The principal mines cover a length of about three miles, and the ore bodies vary in width from a few feet to 400 feet. At the Broken Hill Proprietary mine the outcrop averages about 120 feet wide. The mines have been worked to varying depths. The average depth is about 1,400 feet, and the deepest mine, Block 10, goes down 1,815 feet.

Some idea of the importance of the field may be gathered from the following statistics—the year 1918 being taken because since then, owing to industrial troubles, conditions have not been normal:

| | |
|---|---|
| Tons of ore raised | 1,251,161 |
| Timber used, superficial feet | 13,194,782 |
| Pounds of explosives used | 540,688 |
| Tons of coal used | 152,727 |
| Average number employees per shift | 7,874 |
| Shifts underground | 3,974 |
| Shifts on surface | 3,900 |

From 1903 to 1921 the total number of tons of ore raised amounted to 22,297,069; and the value of the output from the inception of operations until the end of 1921 reached £107,813,489. The moneys paid in the same period for dividends and bonuses equaled £22,871,018.

The ratio of bonuses and dividends to tonnage, from 1903 to 1921, is about 25 shillings to 1 ton. It must be remembered, however, that, except for relatively insignificant quantities contained in remnants, the tremendously rich oxidized ores of lead and of silver above the water line have now been removed. All the operating companies have for some years been extracting primary sulphide ores.

The Barrier Ranges may be said to cover about 5,000 square miles, and the state geologist, Mr. E. C. Andrews, B. A., estimates that about 13,000,000 tons of ore are in reserve at the present time, with a possible maximum of 20,000,000 tons. Mr. Andrews has recently made an exhaustive examination of the area, and his 1922 report deals with the general geology of the district and the origin of the ore bodies.

The rocks of the region were originally sediments—such as clay stones, slates, conglomerates, and shales which have been intensely folded and contorted—with a marked development of sillimanite schist at the center of the disturbance. The folding resulted partly from rock flowage deep down in the earth and partly from the effect of igneous intrusions of granite, amphibolite, and pegmatite. These were forced between the beds of sediments. Meanwhile, the folding of the rocks became more pronounced—the center of the disturbance being where the mines are now located. This area was subjected most powerfully to the influence of heat and pressure—resulting in a great development from the original sedimentary material of such rock-forming minerals as sillimanite, garnet, feldspar, and mica. To quote Mr. Andrews: "At the close of the period of heavy folding the ore deposits were formed by emanations from the rock material underlying the area. These emanations were possessed of abnormal penetrating power and proceeded to eat into and replace certain of the folded rocks."

The commercial ore bodies are found in the folded sillimanite schist in places which lent themselves to the replacement action of the mineralizers or emanations when the latter passed through a zone of rock flowage and ascended through a crush or shear zone—forming in this area a tabular lode known in the field as the eastern vein or footwall lode. This lode varies in width from a few inches to 100 feet. The mineralizers passed from the shear zone to the west, eating into and replacing the huge folds in the sillimanite schist. It is from these

*Mine Manager and Assistant Mine Manager, respectively, Broken Hill South, Ltd.

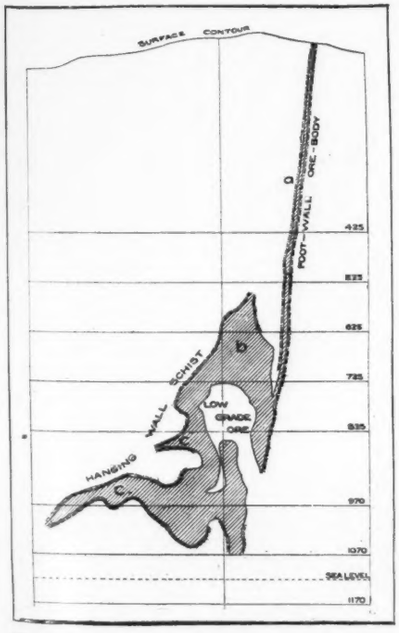



*Fig. 1—A cross section showing typical ore bodies at Broken Hill.*

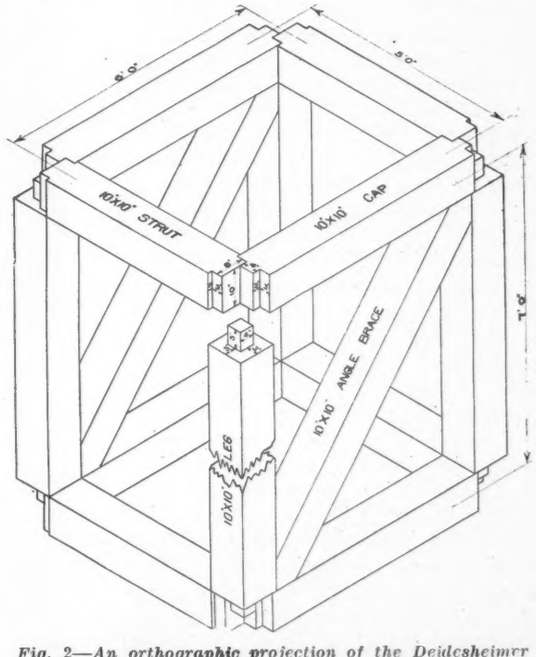



*Fig. 2—An orthographic projection of the Deidesheimer square set, as originally used with angle braces, showing details of the joint.*

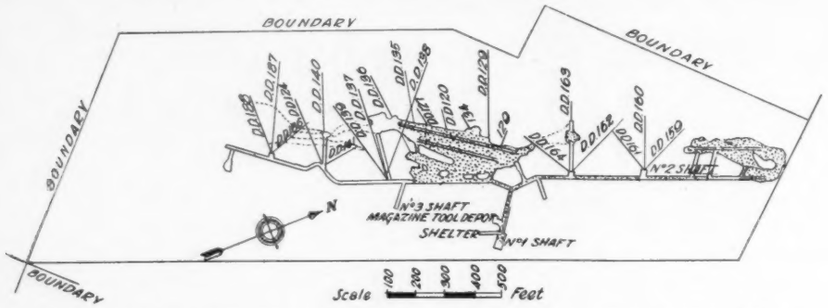



*Fig. 3—How communication is effected on a new level by crosscuts between shafts.*

huge, saddle-shaped folds that the big tonnages of rich ores, which have made the field famous, have been for the most part obtained. A tremendous upthrust fault, together with the effect of subsequent erosion and denudation, was responsible for the exposure of the ore bodies at the surface. Fig. 1 is a typical cross section, showing both the footwall lode, a, and the saddle-shaped replacement ore bodies, b and c, in folds of the sillimanite schist.

Viewed from the east or the west, the lode has the appearance of a longitudinal arch having its apex near the center of the field, from which point the bodies pitch north and south following the undulations of the crumpled sillimanite schist. These great saddles are not continuous, but occupy separate crinkles or corrugations in the folded bed of the schist.

When the Broken Hill lode was first discovered back in 1883, the outcrop consisted of a craggy mass of brownish-black rocks, and was called the "Hill of Mullock." The finder was a sheep-station employee named Charles Rasp, who formed a syndicate to investigate the mineral possibilities of the field, being under the impression that he had discovered a valuable deposit of tin ore. The first results following the sinking of Rasp's shaft were discouraging; and two of the original shareholders dropped out, disposing of their shares for less than £100 each. These shares subsequently rose to a value of £2,500,000 each. However, the syndicate persevered, and silver chlorides were ultimately found in Rasp's shaft at a depth of about 100 feet. Shortly afterwards, rich chlorides, carrying from 700 to 800 ounces of silver to the ton, were located at the surface but at another place on the outcrop. The outcrop was largely composed of manganiferous limonite, that is, hydrous oxide of iron and manganese, and varied in width from 10 to 120 feet.

The natural water level is about 300 feet below the surface. The enrichment which the ore bodies had sustained down to this level, as a result of the leaching and the oxidizing action of descending waters, was enormous. Numerous vugs were formed, and these contained crystals of carbonate of lead, chlorides, iodides, chlorobromides of silver, and also stalactites of oxide of manganese. Native silver and copper were likewise developed. The secondarily enriched sulphides occurred beneath the oxidized zone, and consisted of an intimate mixture of fine-grained argentiferous galena and zincblende—the gangue being quartz, garnet, rhodonite, and feldspar, with some iron and copper pyrites. As previously stated, mining operations are now for the most part centered upon the primary sulphide ores—the valuable minerals being galena (lead sulphide), sphalerite (zincblende or sulphide), and the silver which is associated with those minerals.

The ore bodies have been roughly divided into two main classes, namely, those with a calcitic or carbonate gangue and those with a rhodonitic or siliceous gangue. The calcitic gangue ore bodies are at the northern and the southern extremities of the line of the lode while the siliceous gangue ore bodies are in the

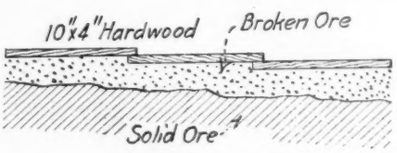



FIG. 5

center, though ore bodies containing both classes of gangue are found in the field. The ore bodies as mined contain about 14% lead, 14% zinc, and seven ounces silver.

The following analyses are typical of both classes of ore:—

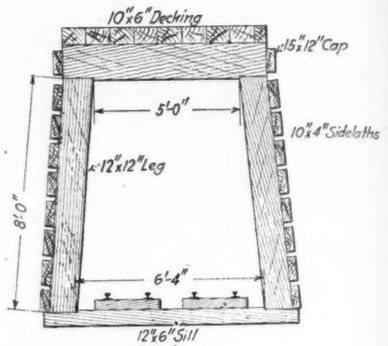



FIG. 4

| Mineral | Siliceous Ore Per cent. | Calcitic Ore Per cent. |
|---|---|---|
| Insoluble | 37.71 | 30.12 |
| Lead | 15.50 | 13.40 |
| Copper | .10 | .20 |
| Arsenic | .18 | .43 |
| Antimony | .03 | .06 |
| Iron | 4.90 | 3.03 |
| Alumina | 2.40 | 1.25 |
| Manganese | 2.47 | 1.70 |
| Lime | 4.00 | 15.70 |
| Zinc | 17.00 | 12.60 |
| Sulphur | 13.80 | 9.70 |
| Carbon dioxide | 1.30 | 11.60 |
| Fluorine | .24 | .078 |
| | 99.63 | 99.87 |
| Silver, ounces per ton.. | 11.7 | 3.2 |
| Composition of Insoluble | Per cent. | Per cent. |
| Silica | 67.6 | 56.0 |
| Ferrous oxide | 4.6 | 6.6 |
| Alumina | 4.6 | 3.5 |
| Manganous oxide | 19.5 | 17.7 |
| Lime | 3.0 | 13.0 |
| Magnesia | .9 | 2.5 |
| | 100.2 | 99.3 |

The mining practices in the field have passed through many different stages as a result of the experience gained and also by reason of the fact that the physical conditions of the ore bodies are now quite unlike those of the earlier days. Mining operations were first directed to working the rich oxidized and secondary sulphide ore bodies of the Broken Hill Proprietary

*Fig. 6—Here are shown gangways, filling, and bottoms in sill floor stope.*

Company, Ltd., and the Block 10 and Block 14 companies. The ore bodies were extremely loose and friable in character and were contained within very weak schist walls. In some cases, these ore bodies were worked to a depth of 300 feet by means of surface quarries; but, with increasing depths, it became necessary to devise new methods.

Mr. W. H. Patton, an American mining engineer, was responsible for the introduction of the Deidesheimer square set. The general appearance of this timber framework, with a detail of the joint, is shown in Fig. 2. The timber used was 10x10-inch Oregon pine. The joints were fitted with great care, and the structures were reinforced by means of angle braces as illustrated. Experience soon revealed that these sets, unless strengthened by the systematic use of filling, were inadequate to provide the safe conditions necessary to permit the recovery of the ore no matter how securely they were framed together and blocked to the sides of the excavation.

The bulk of the ore extracted today is drawn from ore bodies consisting of primary sulphides. Though the sulphides are more compact and of better standing quality than the oxidized ores, still the schist walls are often very weak. Moreover, faults and local weaknesses, due to creep resulting from bad practice in the early days, still call for the use of square sets in many places. They are also systematically applied in the extracting of ore from the bottom of levels.

The following description of the methods employed in opening up and in removing the ore is based on the practices of one of the larger producing mines. But before reciting these details it might be well to give the names of the principal companies now operating in the Broken Hill district. These are: North Broken Hill Company, Ltd., Junction North Mine, N. L., The Broken Hill Junction Lead Mining Company, N. L., The British Australian Broken Hill, Ltd., The Broken Hill Proprietary Block 14 Company, Ltd., The Broken Hill Proprietary Company, Ltd., The Broken Hill Proprietary Block 10 Company, Ltd., The Sulphide Corporation, Ltd., Broken Hill South, Ltd., and The Zinc Corporation, Ltd.

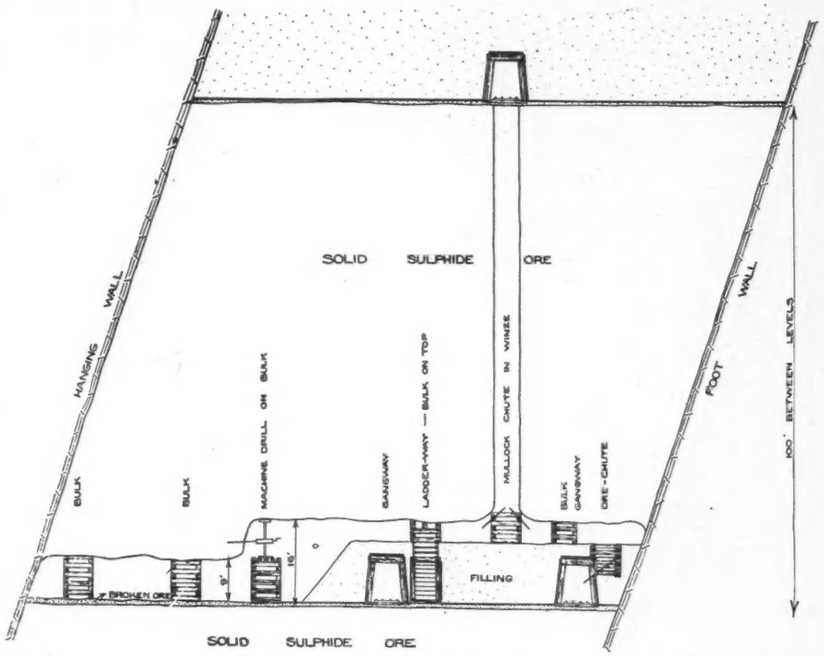



*Fig. 7—Illustrating manner in which stope may receive its first filling and become an open stope according to the practice at Broken Hill.*

In the footwall lode, the shafts are sunk to the east of the ore bodies. Communication between the shafts on any new level is effected by crosscuts and drives in country rock, as shown in Fig. 3. Along the main drives, chambers 15 feet square and 10 feet high are cut at points 150 feet apart. Diamond-drill holes are then bored in such a direction as to yield the maximum amount of information respecting the location and the value of the ore bodies. This is of especial importance in view of the pitch of the ore bodies and their consequent change of position in relation to the hauling shafts in passing from one level to another. The data thus obtained can then be used to determine, from the level above, the position of the winzes, the sinking of which is at once started. Simultaneously, crosscuts may be extended from suitable locations on the main drive to give access to the ore bodies and also to effect connections as soon as possible with the winzes from the level above. This is desirable in order to provide facilities for the subsequent mullocking (mucking) and ventilating of the workings on the new level.

When the crosscuts have reached the ore bodies, sill floor stopes are started. These are carried nine feet high and extended to the walls of the ore bodies. Ordinarily, in open-stope practice, which is the method herein described, timber balks of 10x10-inch Oregon pine are built at regular intervals of twelve feet or so to act as temporary local supports for the roof. Where the ground is weak, however, square sets may be built. The surveyors supervise the grading of the stope bottom or sill floor.

Plans are next prepared showing the position, grade, etc., of the timbered gangways for the sill, together with other details relating to the location of chutes, ladderways, and winze sets. But before these can be erected it is necessary to cut an additional seven feet from the roof, making the height sixteen feet from floor to roof. Sufficient headroom is thus provided for the accommodation of the gangways. In the case under discussion, Australian hardwood *eucalyptus obliqua* is used—the gangway set consisting of four pieces: the cap, two legs, and a sill, as may be seen in Fig. 4. Oregon pine has also been largely utilized for gangway timbering.

*Fig. 8—Distributing filling and rearing a chute in an open stope. Chutes permit the removal of broken ore and are built in the filling as the work progresses.*

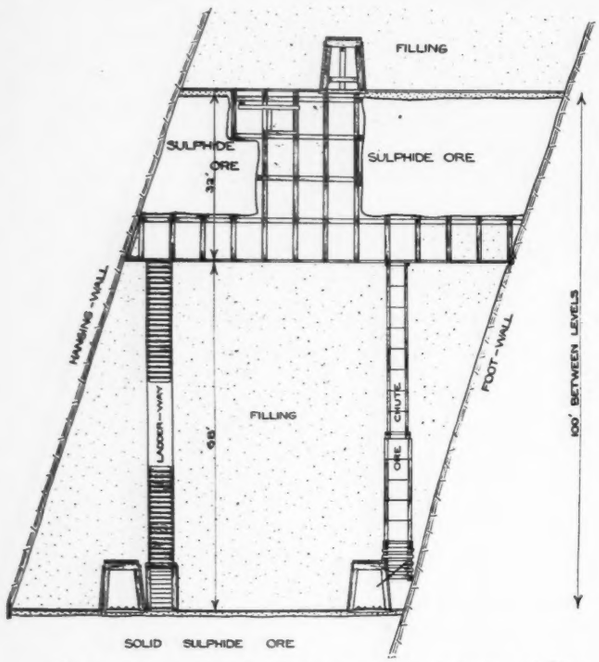



*Fig. 9—An example of underhand square-set stoping picking up floor of level.*

Simultaneously with the erection of the gangways, a wooden floor of 10x4-inch hardwood, eight feet long, is laid on the bottom of the stope. This is done in order to facilitate the removal of the ore from the level below, at a later stage, when extraction operations are in progress. The wooden floor is provided with a good bed by spreading a thin layer of filling or broken ore, as shown in Figs. 5 and 6.

The stope may now receive its first filling, and then becomes an open stope as illustrated in Figs. 6 and 7. The filling is brought up to within four feet of the back, and balks of timber are built on the filling and wedged up tight to the back where necessary. The cutting off of horizontal slices of ore, about eight feet thick, alternates with the introduction of layers of filling, which reach to within four feet of the new roof or back. Chutes to permit the removal of broken ore and ladderways to provide means of communication to the sill are built up in the filling as the work progresses. These activities are depicted in Fig. 8.

The vertical distance between levels varies in different mines, and is controlled largely by the regularity or, otherwise, by the pitch and the dip of the ore bodies, as these factors have a great bearing on the life and the maintenance costs of the ore chutes. Main levels, however, are seldom less than 100 feet apart, and, provided the ground is sufficiently strong, the open-stope method of mining may be carried up to within 30 feet of the level above. At this point a light stope is then taken off the back, and a floor of square sets is stood upon the filling and blocked up to the back. These are back-filled, care being taken to leave suitable openings connecting with the winzes from the level above and with the chutes and ladderways from the level below.

The winze that is chosen as a starting point for stoping operations is stripped, and two square sets are carried down within it to join onto the horizontal row of sets 30 feet below the level. The weight of the gangway sets over the winze is distributed, by means of timber framework such as booms, over those sets that remain footed on solid ground adjacent to the winze. Fig. 9 gives a general ideal of the method adopted.

The sets are six feet square in plan, with legs seven feet long. The usual practice is to leave a space of one foot over the top set to allow for blocking to the gangway timber of the level. In the case of old workings, it is sometimes found that the timber bottoms constituting the floor of the level have rotted away, or that no bottoms were ever laid. It is then necessary to carry laths, eight feet long and of 5x4-inch section, in advance of the work so that the filling of the level above may be temporarily supported while the top ring of the square-set timber is being placed in position. The ore is extracted in successive vertical strips connecting the level and the floor of the filled square sets, 30 feet below.

Rigidity is given to the timber structure by binding the joints with iron dogs, as illustrated

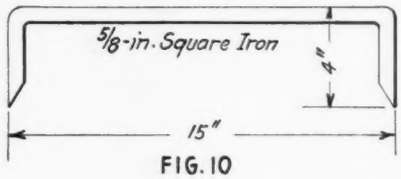



FIG. 10

in Fig. 10, and also by blocking the joints to the boundaries of the excavation; while the weight of the sets which are being erected is distributed over those which are already in position by the employment of timber booms used as cantilevers.

When a sufficient number of sets have been extracted, 8x2-inch paddocking laths, six feet long, may be nailed to the timbers, and the enclosed space filled in. This method is known as the underhand, square-set method of mining; and, used in judicious combination with the open-stope, flat-back system previously described, has been found capable of dealing with any of the conditions encountered in the great Broken Hill mining district.

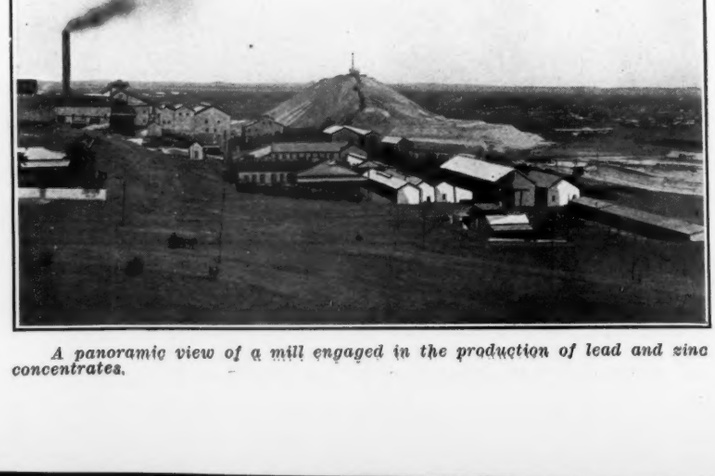
(To be concluded).

## DEVICE FOR DRYING SAND

IN THE sand blast it is very important that the sand be perfectly dry so that it will flow without clogging. A device for drying sand, originally designed for another purpose, is in use in England, and is described in the *Foundry Trade Journal*—the official organ of the Institution of British Foundrymen.

The apparatus is based upon the familiar fact that wet sand is cohesive and clingy, and that when perfectly dry it runs almost without friction. It consists of a sheet-iron tank, the cross section of the bottom of which roughly resembles the letter W. At the base of the two Vs, which go to make the W, a ¼-inch slot is left open, and between the Vs runs a small gas pipe with several burner holes. The two Vs and the tank above them are filled with wet sand and the burner is lighted. As the sand near the burner is dried the surface tension in the wet sand is destroyed, and it drops in a dry state down through the slots to a receptacle below.

The discovery of a new fiber, known as *malvavisco*, which is said to be a substitute for jute, is announced by the Industrial Experiment Laboratory of the Mexican Department of Commerce and Industry. The plant grows abundantly in the humid, level lands near the rivers, and is now used in Vera Cruz for the making of brooms. Extensive experiments have shown *malvavisco* to possess qualities similiar to jute; and the fiber, which has a silky appearance, has been woven with excellent results into cloth. The cost of extracting the fiber is said to be small.



*A panoramic view of a mill engaged in the production of lead and zinc concentrates.*

# Testing the Durability of Building Rock by Man-Made Weather

BY G. H. DACY

THE CAMPAIGN waged by Herbert Hoover, Secretary of Commerce, to decrease building costs by the employment, among other things, of nothing but the most satisfactory materials has led to some unique rock-testing work which makes it possible to ascertain in the laboratory in a month's time data that it would require Nature about half a century to reveal. The object of the investigations is to determine by a process of alternate freezing and thawing, in other words by simulating varying weather conditions, the durability of different kinds of building rock. To this end, government experts have recently been testing out in a research refrigerator hundreds of samples of all sorts of rock used for building purposes.

A refrigerator, whose temperature is regulated by a small, commercial ice machine suitable for the manufacture of 1½ tons of ice daily, is utilized to freeze the rock samples in exactly the same manner in which they would freeze if exposed to the rigors of our northern winter climate. Freezing and then thawing dry rock does not cause much damage. It is when the rock is saturated with moisture that the low temperatures do most harm. In the dry, arid regions of the West, rock suitable for building purposes will last for centuries, whereas the same rock when exposed to the humid atmosphere in the states along our Atlantic seaboard, will fail in from 30 to 50 years.

Many of the obelisks and statues which have withstood the ravages of time under the dry climatic conditions prevailing in Egypt would have crumbled and fallen to pieces after 30 or 40 years' exposure in the damp and cold sections of the United States; and "Cleopatra's Needle," in Central Park, New York City, and other ancient Egyptian monuments brought to this country, would never have survived our weather extremes but for the frequent applications of waterproof paints and finishes.

The White House, in Washington, and the original part of the National Capitol were constructed of Virginia sandstone, which has low powers of resistance to the weather. If both these government buildings had not been coated every year or so with a waterproof paint they would have crumbled and collapsed after about four decades of service, situated as they are where alternate "freezes" and thaws are common occurrences during the late winter. In the month of March, for example, of a year not long past, that section was subjected to alternate freezing and thawing on 26 occasions. These abrupt temperature changes are hard on rock-building material.

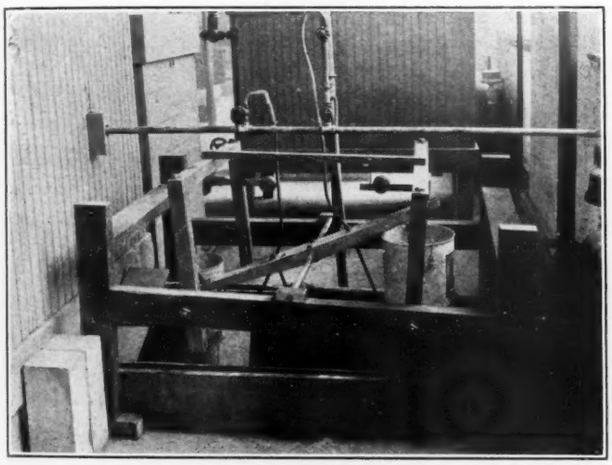
Government tests of granite, limestone, sandstone, marble, brick, concrete, mortar, terra cotta, and many other porous building materials susceptible to frost, have been made in the unique ice box devised and built by Dr. D. W. Kessler of the Bureau of Standards. The refrigerator consists of three sheet-iron tanks, one inside the other, insulated by as many wooden chests lined with cork. In the bottom of the big ice box are three pipes—a drain pipe, an overflow pipe, and one that conducts water into the refrigerator to thaw the rock samples after they have been frozen. A pair of tilting buckets, secured directly to the chest, operate two valves. These valves serve, respectively, to control the flow of water into the ice box and to shut off the supply so as to induce lower temperatures and thus to freeze the saturated rock.

A special contrivance attached to the refrigerator automatically records, on a temperature chart, the rise and fall of the thermometer during the progress of the tests, and indicates the temperature conditions within the different rock samples. The temperature recorder is known as a thermocouple pyrometer. The thermocouple consists of two small wires of different metals which are fused together at two points. One of the joints of the instrument is sealed inside a rock sample whose temperature is to be determined, while the other, which acts as a check, is placed in an ice bath, the temperature of which is kept constant. Both, in turn, are linked up with a recording galvanometer, the needle of which is pressed down on the chart of every 30 seconds. In each case, the temperature drops rather rapidly until the freezing point is reached, and for some time thereafter it goes down but slowly—this latter period representing the stage during which the water in the specimen is being converted into ice. Generally, twelve alternate freezings and thawings can be accomplished in the course of 24 hours; and it is interesting to note that six such freezings and thawings of specimens in the government laboratory are equivalent to an exposure of one year in the City of Washington.

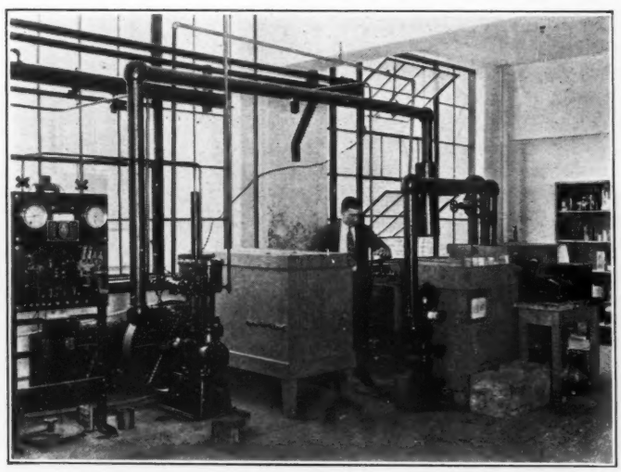
As a result of these investigations, the Federal experts are comparing the efficiency of one building stone with another and are eliminating as unsatisfactory many materials which have been widely used in certain sections of the country where they are found in abundance. They have worked out a sort of score card by which they are able to determine with a measure of accuracy the kinds of rock suitable for construction purposes in different climates.

The qualities of the rock that control the action of frost are: strength, porosity, and the rate at which the material will dry after being saturated with water. In the United States the climatic extremes greatly complicate any attempt at standardizing building rock. A type of stone that may be very satisfactory in one place may be entirely unfit in another. The famous marbles of the Mediterranean countries, which can withstand for hundreds of years the weather prevalent in that part of the world, are attacked very rapidly when brought to America and used in the eastern and southern states. Usually these imported marbles are not as durable as our native marbles.

Our best Vermont granites will endure, with



*The tipping buckets are part of the arrangement by which specimens in the refrigerator are alternately frozen and thawed to simulate changing weather conditions.*



*The results of one day's retention of rock in the ice box of this plant are equivalent to the weathering effects of a year's exposure out of doors.*

proper care, anywhere from 500 to 1,000 years when exposed to atmospheric conditions such as prevail throughout the New England, Middle Atlantic, and South Atlantic States. In the arid West, however, they will last relatively longer. High-grade Vermont marble will stand up well without waterproofing for a century and more. The new wing of the National Capitol

*Doctor Kessler is testing the durability of all kinds of rock in order to help towards reducing building costs in America.*

is built of Massachusetts marble, which is showing excellent wearing qualities.

The Federal investigations and the tests made prove conclusively that the shipment of building rock from one section to which it is indigenous to another to which it is unsuited should be discouraged. This practice, as has been definitely established, tends greatly to increase building costs not only by reason of the lessened wearing quality of the material, but because of the high freight rates. Uncle Sam is continuing the unusual research work, the first of its kind ever attempted, and aims to carry it through to conclusions which will be both of scientific and practical value in the selection of building rock best suited to the locality in which it is to be used.

## WATER POWER FROM ARTESIAN WELLS

THE artesian wells which are quite numerous in the northern and the middle sections of Florida discharge their waters with considerable force and velocity. An enterprising local inventor has developed some small reaction turbines to be mounted directly over the wells and to be driven by the upward impact of the water. They are made in sizes from 150 to 2,000 watts, say ¼ to 2½ H.P., directly connected to 32-volt or 110-volt direct-current generators.

A storage battery is used with each outfit—the generator charging the battery at a low rate. The arrangement is very simple—no speed governor or electric regulator being required. The farmer thus gets his light and power and still has enough water left for irrigating purposes. There are several localities along the Gulf Coast and elsewhere where the system could find ready employment.

## PNEUMATIC RETRIEVING OF METALLIC ABRASIVES

THE use of metallic abrasives, such as chilled iron shot for the sand blast instead of natural sand, is now quite common. These heavier particles strike the surfaces with greater force on account of their weight, and, for many purposes, are therefore more quickly effective; but, generally, they are preferred because they are much more lasting and can be used over and over again.

When employed for cleaning castings and for similar purposes, however, the metallic abrasives become mixed with large quantities of sand, and unless this can be separated from the mass it must soon be discarded. The separation and the recovery of the metallic shot from the sand and dirt have been attempted by sifting and screening and by other means, but with little success.

A pneumatic separator has now been devised which is proving entirely satisfactory. It is made a part of the ventilating system of the W. W. Sly Manufacturing Company's sand-blast system. The expansion of the air current and an ingenious arrangement of two baffles in the separator permit the metallic abrasive to drop and to be discharged, while sand and dust and all the lighter material, regardless of size, are carried along by the current.

A restricted discharge opening permits the entry of a small supplemental volume of air which gives the abrasive a so-called final washing. The air supplied for ventilation, independent of the sand blast, is put to two additional tasks, that is, lifting the cleaned abrasive for return to its work and thoroughly cleaning and separating the abrasive from the refuse. The arrangement is quite simple and has no mechanically moved parts that require attention.

## AIR LOCK FOR FREIGHT CAR DOORS

CONSIDERABLE interest has been shown in a new air lock and signal apparatus, to be used on freight cars, that has been invented by E. M. Boyle, a conductor on the New York Central Lines.

The device consists of a cylinder and a spring attachment, which is connected to a latch. When a car door is closed, a door catch slides the latch that locks the door, and the latter cannot be opened until the car is coupled to an air plant or to a locomotive.

A governor attached to the device may be set to allow the car to be opened by a pressure of from 10 to 110 pounds of air. As the piston rises it uncovers an opening in the cylinder, to which is attached an air whistle that sounds before the door is opened. It is probable that the working pressure for opening the lock will be about 90 pounds, inasmuch as it is necessary at that pressure to notify the engineer that the door is to be opened. This precaution will prevent car doors from being opened by unauthorized persons.

**The Uruguayan government has under consideration the installation of a meat-freezing establishment for the promotion of the live-stock industry in that country.**

## HANDY TELEPHONE DIRECTORY THAT REVOLVES

GOVERNMENT bureaus, business firms, corporations, and various large enterprises, whose different departments are interconnected by telephone, frequently experience difficulty in keeping readily available a directory of the numbers of the various departments. Alphabetically arranged indices, cardboard on which the numbers are typewritten, and other makeshift methods are being employed; but it remained for the general store of the Chicago & Northwestern Railroad Company to devise a system that is at once ingenious and practical.

The contrivance is a revolving telephone directory, and is in the shape of a wheel, 4¼ inches in diameter, on which approximately 40 telephone numbers are recorded. This wheel is made of a strip of sheet tin, three inches wide and fourteen inches long, and has crimped edges. The double set of spokes of this telephone directory are fashioned from the same material as the wheel proper, and are soldered to the wheel to insure rigidity. The bracket, which holds the device to the telephone, is of light strap iron, and is clamped to the instrument.

The interdepartmental numbers are typewritten on a sheet of paper of proper size, which is pasted on the wheel and then shellaced. The typewritten matter on the directory in question was double-spaced, although

*A simple and inexpensive revolving telephone directory devised for departmental use by a western railroad company.*

where greater capacity is desired, the telephone numbers may be put on in single-space form. The general store of the Chicago & Northwestern Railroad Company is at present employing this revolving directory on automatic interdepartmental telephones; but its usage is not confined to any particular type of 'phone.

About 6,500,000 families are engaged in agriculture in the United States.

# Compressed Air Safeguards the Mariner

BY A. M. HOFFMANN

LAKE MICHIGAN, in the matter of commercial importance, ranks first among the Great Lakes for the reason that it is open to shipping the year through. This accounts for the fact that this big inland sea and its offshoot, Green Bay, have been well provided by the United States Bureau of Lighthouses with various navigational aids to guide the mariner traversing these waterways. In this connection, it is interesting to note that six of the fog-signal stations, built there in years past, have been undergoing systematic improvement, and are now capable of rendering far more effective service at reduced up-keep costs.

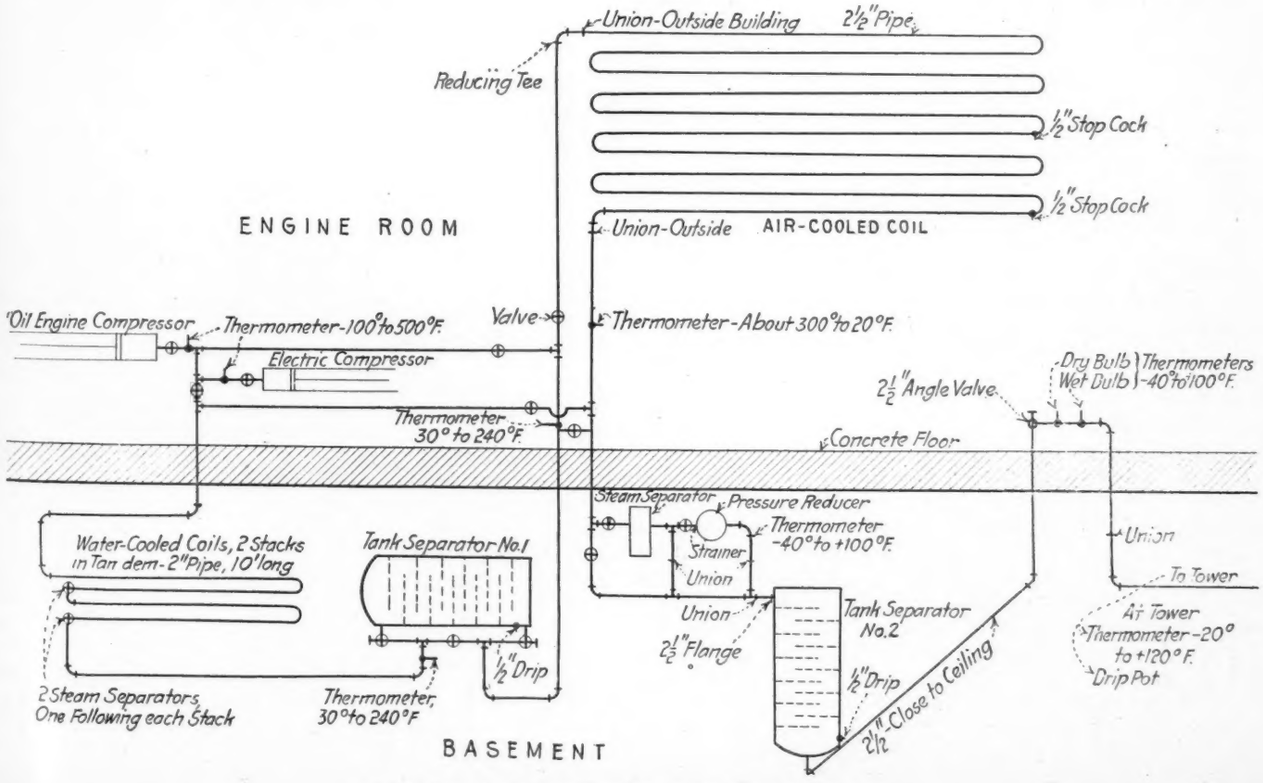
In the early days of the Lighthouse Service, there were erected at each station on Lake Michigan two separate fog-signal buildings, each with its own boiler and whistle, as a safeguard in case of breakdown. This extreme precautionary measure is said to have been deemed expedient because of the character of the country, which was then thickly wooded and subject to forest fires. At that time, about 21 years ago, all the first-class fog signals were whistles, ten inches in diameter, actuated by steam.

In 1902, oil-engine-driven compressors, operating air sirens, were first introduced. These power plants called for signal stations of ample size not only to house the necessary equipment but also for the convenience and the comfort of the men that had to be put in charge. Fourteen years later, a new type of signal, known as the air diaphone, was adopted; and at the same time, the oil engine, which was used to drive the compressor, was supplanted by an electric motor.

*The tower at Sheboygan, Wisc., which was moved from a pier to the outer end of a 4,000-foot breakwater.*

The diaphone possesses the distinctive merit of operating efficiently with low-pressure air, and consumes 12 cubic feet of free air at 30 pounds pressure per second of blast. Each station, as may well be appreciated, has its own characteristic signal—for example, two blasts per minute, each lasting three seconds; or three blasts per minute, each of two seconds; or three groups of two blasts, each of one second duration, etc. Most signals now used have a total period of blast of about six seconds per minute which, at a consumption of twelve cubic feet of free air per second, means a requirement of 72 cubic feet of air or about 90 cubic feet of piston displacement. The pneumatic diaphone has a very distinctive note; and can be heard throughout a radius of from 4 to 28 miles, depending on the condition of the atmosphere.

The adoption of the low-pressure-air system of signaling very much simplified the problem of plant requirements, and made it possible to house the compressor, etc., in a small-sized building or tower. This was of great advantage, inasmuch as it permitted erecting the stations at the outermost ends of breakwaters and piers. By employing a compressor operating at 30 pounds pressure it was no longer necessary to provide the water-cooling system, which was an essential part of the earlier installa-




*General layout of a compressed air fog-signal installation.*

tions when high-pressure-air signals were used. The compressors now in service are air cooled by means of fins projecting on the outside of the cylinders.

With the introduction of electric drive the need of regular manual attendance was generally done away with. In other words, the signals are controlled from the shore; and as all the equipment is of a rugged type that called for little attention it does not have to be inspected more than once a month. Electric power is generally provided from near-by city lines; and the current is transmitted through cables that are either submerged or laid on top of a breakwater, depending on the location of the station served.

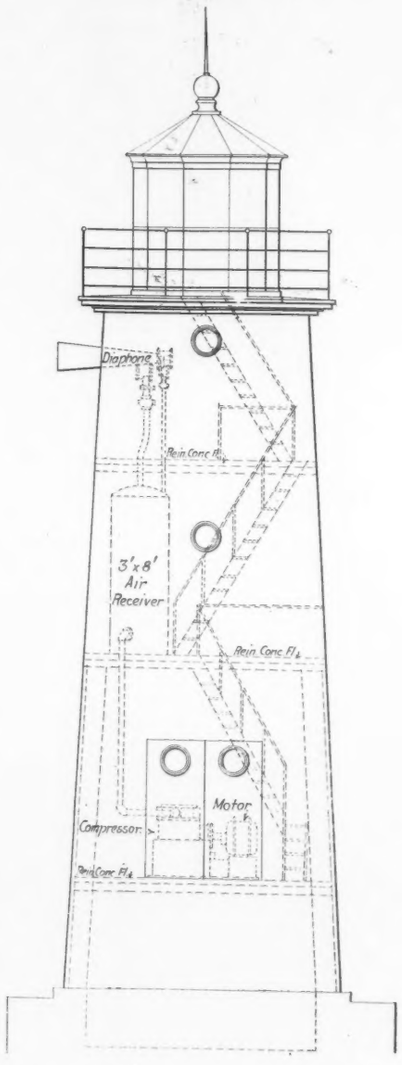
The first electric-driven, low-pressure-air signal station was built in 1916 at Manistique, at the northernmost end of Lake Michigan. The light and fog-signal tower located there stands at the extreme end of the east breakwater, 1,800 feet from shore, and the lighthouse keeper's dwelling, from which point the diaphone is made to give its distinctive blast, is 1,200 feet inshore. In other words, the fog signal is 3,000 feet away from its base of control.

Since its installation, the Manistique plant has given entire satisfaction. The first winter that it was in service some trouble was experienced with the freezing of moisture in the valves and in the diaphone cylinder. However, this was overcome by the use of air-cooled coils. A small drip cock, at the bottom of the air receiver, is left open at all times to permit the blowing off of the condensed moisture. The bottom and the sides of the tank, for a height of about one foot, are insulated so as to prevent the moisture settling there from freezing. The cock is fixed at a point on the receiver where the drip will be kept warm by the heat that radiates from the air pipe leading up from the compressor.

While the station at Manistique was being overhauled under the direction of the Bureau of Lighthouses, another signal station of a somewhat different design was being erected at Sheboygan, Wisc., on the west coast of the lake. This is of the so-called air-transmission type, and uses a 6-inch air siren operating at 57 pounds pressure. The light tower is situated at the outermost end of a breakwater, 4,000 feet from shore, and along the top of this sea wall is run a 2½-inch pipe line that carries the air to the siren from the compressor plant at the shore end of the breakwater. Two compressors are provided at this station: one electric, belt-driven machine for regular service and an oil-engine-driven compressor for use in case of breakdown. The machinery is under constant surveillance when the signal is in operation.

The main problem that entered into the design of this installation was to prevent any possible moisture in the exposed 4,000-foot air line from freezing in cold weather and thus clogging the pipe. So efficient has been the apparatus provided for the removal of moisture from the air before the latter reaches the piping that no trouble from frost has been experienced throughout the seven winters that it has been in service.

By reason of the volume and the importance of the shipping to and from Manitowoc, Wisc., also situated on the west coast of Lake Michigan, and on account of local conditions, it was deemed advisable by the Lighthouse Bureau to place a combined light and fog-signal station of unusual proportions at this port, and one that could be counted upon to function efficiently under all circumstances. To this end, the pneumatic diaphone is so arranged that it can be operated at will right on the spot by either an electrically driven or an engine-driven




*Vertical section of a lighthouse equipped with a diaphone.*

air compressor, or may be worked indirectly from the shore by electric transmission as in the case of the station at Manistique where no regular attendants are required. The motor-driven compressor is air cooled while the oil-engine-driven machine, which is a spare, is water cooled. The design for the Manitowoc Lighthouse was approved April 30, 1918, and that plant has since been completed. It is also located at the end of a breakwater.

Following the installations described, the Twelfth Lighthouse District similarly improved the three air-signal stations located at Kewaunee, Wisc., and Point Betsie and Frankfort, Mich. And so satisfactory has been the service rendered by them all, apart from proved economy of operation, that three other stations in the same lake region are now being overhauled and changed from steam to electric drive. As a matter of fact, the object is to remodel all the old stations along the lines outlined as fast as the boilers wear out and warrant the substitution. As most of the towns and cities situated on that busy inland sea have electric plants that may be depended upon to supply the necessary power, the work of effecting the changes will be fairly simple.

In this connection it may be of interest to note that at the close of 1923 the following different aids to navigation will be in use along the shores of Lake Michigan to warn the mariner; and these figures reveal how many steam whistles are still employed which will ultimately be supplanted by electro-pneumatic signals of one sort or another.

| | | |
|---|---|---|
| Steam whistles | | 27 |
| Air whistles | | 3 |
| Air Sirens | | 9 |
| Oil-engine-driven type | 8 | |
| Electric air-transmission type | 1 | |
| Air diaphones | | 9 |
| Oil-engine-driven | 1 | |
| Motor-driven | 8 | |
| Submarine bells, driven by compressed air | | 4 |
| Bells, operated by clockwork | | 9 |
| Horn, operated by hand | | 1 |
| | | 62 |

Now to return to the matter of cooling coils. The principal lesson to be learned from the fog-signal installations, from the standpoint of the user of compressed air, is that very satisfactory results in cooling and in drying the air may be obtained at small cost by means of simple trombone coils cooled by V-shaped, water-drip troughs, or by the same kind of coils exposed to the atmosphere on the north side of a building, tower, etc. In any case water separators are essential, inasmuch as the diaphone works more effectually with dry air.

Air cooling coils, as described, together with water separators, are installed at all electric-driven signaling stations, even where there is little or no danger of the moisture freezing in the valves and in the diaphone cylinder. At the light and fog-signal stations now being equipped at Indiana Harbor and Calumet Harbor, South Chicago, coils cooled by dripping water will be used to thoroughly dry the air in order that no trouble may be experienced from frost in the diaphone or the "Little Tugger" lift that is provided to operate the boat hoist.

In conclusion be it remarked that the introduction of electric-driven compressors for fog-signal service in the Twelfth Lighthouse District has not only made for more efficient operation at a minimum cost, but, in consequence, the diaphone responds more quickly to the impulse of the operative air. And, besides, the cost of up-keep is reduced materially, fewer attendants are required, and the expense of delivering coal by the lighthouse tenders is eliminated.

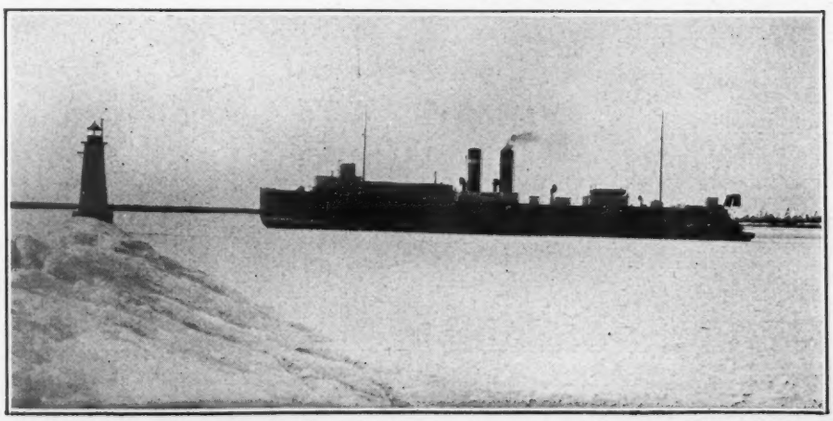
The writer wishes to thank Mr. Norris M. Work, First Assistant Superintendent of the Bureau of Lighthouses, for the assistance rendered in the preparation of this article.

*The Sheboygan light and fog-signal tower at the end of the 4,000-foot breakwater. A 2½-inch pipe line runs the entire length of the sea wall and carries operative air to the pneumatic siren.*

*A c'ose-up of the Manitowoc station showing the air diaphone projecting lakeward from the side of the light tower. The cooling coils are also to be seen on the right of the building.*

*A busy scene at the locks of the Sault Sainte Marie on the Great Lakes.*

*The 2½-inch air-cooling coils on the north side of the fog-signal building at Point Betsie, Mich.*



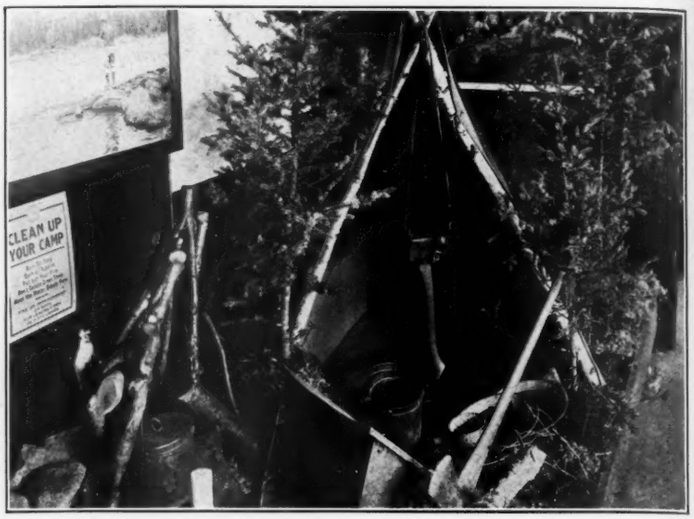
*A car ferry leaving the port of Manistique with the east breakwater tower to the left.*

## MOBILE FOREST EXHIBIT INVITES VACATIONIST

WHERE SHALL I spend my summer holiday? This is the question asked each year by hundreds of thousands of our people. Just what has been done by the Forest Service of the United States Department of Agriculture and one enterprising railroad to help answer the question is the reason for what follows.

A miniature forest traveling by rail *de luxe* is the most novel form of invitation recently conceived by Uncle Sam to encourage the citizens of half a dozen or so states to make use of the National playgrounds. Fishing, hunting, canoeing, and other kinds of recreational opportunities to be found in the 156,500,000 acres of National forests have heretofore been attractively advertised through the medium of text, pictures, models, etc., but this is the first instance in which a transportation company has placed a parlor car at the disposal of the Forest Service to stage an exhibition of a forest on wheels.

The Superior National Forest, located in northeastern Minnesota, was, figuratively speaking, carried within the confines of a railway coach. Products of this forest, both animate and inanimate, in the shape of mounted specimens and life-size and miniature models were included in the display. Deer, rabbits, squirrels, ducks, fish, and birds indigenous to the region were to be seen in this make-believe, small, traveling forest. A tent, a fireplace, cooking utensils, a birch-bark canoe, axes, a model stove, a fireplace with an electric fire burning, and dummy packages of food for a ten-day camping trip, together with the transparencies, in the windows of the car, of scenes in the Superior National Forest created an environment smacking of life in the woods. Two log ranger stations lent further reality to the exhibit, and a forest ranger, in spirit rather than in person, cautioned the would-be tourists to make judicious use of the hunting and the fishing privileges.




*A corner in the car rigged up to make a strong appeal to the camping tourist.*

The transformation of a parlor car into a replica of a National forest was an idea conceived by H. Johnson, Vice President of the Duluth & Iron Range Railroad. Up in the northeastern portion of Minnesota, through which this road runs, is a veritable paradise for fishermen and canoeists. Highways are almost as scarce as the proverbial "hen's teeth," while waterways are so numerous that canoes are the most common mode of transportation. The section probably offers a wider range for this sport than any other region of equal size in the United States.

The use of the National forests for recreation is not only invited but is heartily encouraged by the Forest Service, administrator of Uncle Sam's woodlands. Mr. Johnson of the Duluth & Iron Range Railroad, after appraising the wealth of opportunities for enjoyment on the lakes of the Superior National Forest, came to the conclusion that more people should know of the advantages offered by this Government preserve. Photographs and literature, as attractive as they might be, were not enough to call the attention of other states to the delights that beckoned to the playgrounds of Minnesota. Such, doubtless, was the line of reasoning of this official when he determined to inaugurate the advertising parlor car.

The railway coach was equipped at a cost of approximately $5,000. The Forest Service prepared the specimens, arranged the exhibit, and furnished an official as lecturer on the extended tour through six states—the car traveling as far west as Omaha and covering a distance of 2,000 miles. About 33 lectures were delivered to an aggregate audience of 10,860—lantern slides being employed in many instances to demonstrate the proper ways to enjoy the recreational facilities of this "Fisherman's Paradise." Forest conservation, too, was emphasized; and by the aid of such placards as "Bury tin cans," "Burn all rubbish," "Put out your fire," "Don't deface green trees," and "Keep the water supply pure," the forest-ranger station in the coach preached the gospel of cleanliness.

By actual count, it was found that 57,349 persons went through the car for observation purposes. For a time an average of 3,000 visitors a day inspected the display. This example of collaboration between Uncle Sam and a transportation company suggests that other railroads might imitate the innovation to the advantage of both the Forest Service and the common carrier, not to mention the public bent upon seeking worth-while places for vacations.

*An exhibit of fish, game birds, and the smaller four-footed denizens of the Superior National Forest in northeast Minnesota to lure the fisherman and the hunter.*

## POWERFUL MINE HOISTS

At the north vertical shaft of the Randfontein mine, in South Africa, there is installed one of the most powerful electric hoisting equipments in the world and also one of the most rapid. Each individual hoist raises a load of 10,000 pounds of ore from a depth of 5,000 feet and at a speed of 4,000 feet a minute—the speed being reduced one-half when men are carried. The work is continuous night and day; and the hoists lift, collectively, as many as 40 loads an hour.

# The Shandaken Tunnel Nearing Completion

## For More Than Four Years the Drillers Have Been Pushing Onward Through Solid Rock But Have Now Holed Through the Last of the Headings

BY A. S. TAYLOR

**THE Shandaken Tunnel has been holed through; and by the end of the year it will be lined with concrete from end to end and ready to send southward 300,000,000 gallons of water daily to amplify the present supply of New York City.**

**This tunnel is one of the two outstanding features of the Schoharie development of the Catskill Water Supply System; and by means of this aqueduct it will be possible to turn the waters of Schoharie Creek from their normal course and to lead them right through the very backbone of the Shandaken Mountains.**

**The rapid execution of the undertaking, which has involved breaking a passage through more than eighteen miles of solid rock, has been achieved in record time by utilizing pneumatic tools and by employing compressed air for various services.**

HOW DIFFERENT is the task of the modern engineer from that confronting Moses when he was called upon to aid his thirsting followers. The leader of the Israelites had only to tap the rocks with his rod and water flowed abundantly; but to satisfy the water needs of the denizens of America's Metropolis it has been necessary latterly to break a passage more than eighteen miles long through the stony backbone of a range of mountains!

To drive the Shandaken Tunnel, the army of underground toilers have brought to their aid nearly 120 powerful pneumatic drills; have used many thousands of pounds of dynamite; and have had to keep continually at their subterranean labors for more than four years. Indeed, if we count the time spent in sinking eight essential shafts at different points along the line traced by the tunnel, the period involved actually dates from the first breaking of ground early in 1918. It might be mentioned here that the sinking of these shafts, aggregating 3,238 linear feet, has entailed the excavating of 26,625 cubic yards of material—mostly rock.

As originally planned, the intention was to prosecute tunneling from seven of these shafts simultaneously, driving headings from each of them in a north and a south direction along the prescribed line—the south heading from Shaft 3 and the north heading from Shaft 4, for instance, advancing toward a common meeting point. This procedure was followed generally with the exception of Shaft 2 which, after its sinking to the prescribed depth, was not used as a base of operations owing to its somewhat inconvenient approach. Instead, the engineers elected to push onward from Shaft 1 and Shaft 3, with the bottom of Shaft 2 as their common goal. As it turned out, however, they met at another point; and it was the holing through of the rocky barrier there that finally breached from end to end the 18-mile tunnel.

The first headings were holed through on April 1, 1922, and at that time the rock was opened up between Shafts 4 and 5; and the next occasion for rejoicing was the holing through between Shafts 5 and 6, which occurred during the latter half of May of the same year. The point of meeting was about 6,800 feet north of Shaft 6 which, by the way, is the deepest of the shafts—extending downward from the valley surface 647 feet. Working steadily onward, the Ulen Contracting Corporation, the active representative of the Shandaken Tunnel Corporation, forged ahead and effected the final holing of the rock, between Shafts 1 and 3, on the 13th of the past February at 3 o'clock in the morning. The total distance covered to make that junction was 23,819 feet.

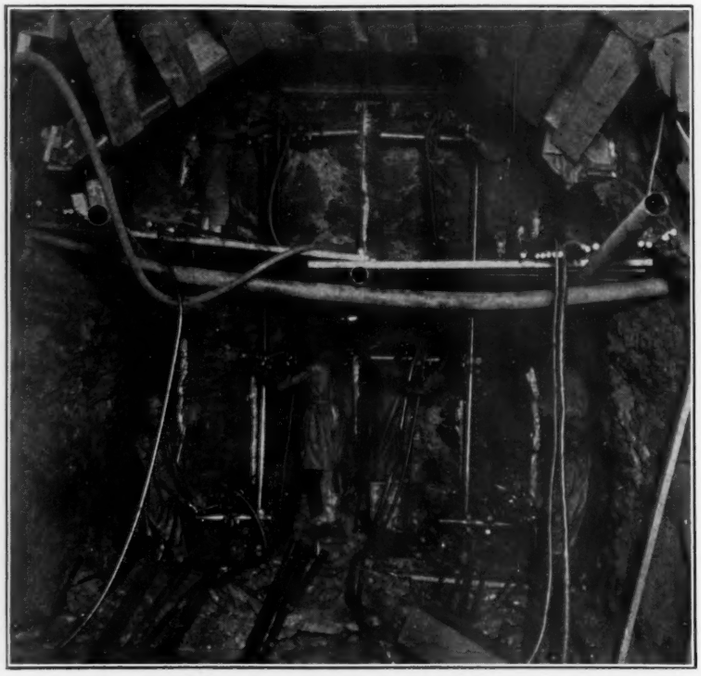
The foregoing bare statement fails to give more than a hint of the magnitude of that particular section of the tunnel job, which was brought to a successful climax in February. Perhaps we can make this plainer by mentioning a few details. To be exact, the tunnel measures from end to end 18.1 miles and is, therefore, 5.7 miles longer than the famous Simplon Tunnel under the Alps. The tunnel is horseshoe-shaped in section and, with the lining in place, has a clear passageway 11½ feet in height by 10¼ feet in width. With the exception of the northerly end, the tunnel generally has a uniform grade or dip of 4.4 feet to the mile as it runs southward toward its discharge portal, where the water to be led through it will pour into Esopus Creek to journey onward in the open air to the great Ashokan Reservoir.

As is shown by the diagrammatic longitudinal section, the intake shaft at the north

*"Jackhamer" and pneumatic clay digger speeding up excavation in the soft-ground section of the tunnel. The "Jackhamer" serves to dislodge or to break up shale.*

*"Leyner" sharpener and oil furnace in the blacksmith shop for handling drill steels for tunnel work.*

end connects with the tunnel at a level considerably below the hydraulic gradient of the greater part of the rock-hewn waterway. The reason for this is due to the fact that exploratory borings revealed the existence of a pre-glacial gorge; and in order to insure a covering of from 70 to 80 feet of solid rock the first 18,000 feet of the tunnel slopes up hill 135 feet. Accordingly, the heading which started southward from Shaft 1 had to climb to a point in line with the general gradient and then to advance therefrom on a downward course until it met the upward-bound heading working toward it from Shaft 3. It is a matter of wonderment to the uninitiated how the oppositely progressing headings were brought together with a variation from the vertical of not more than ¼ inch!



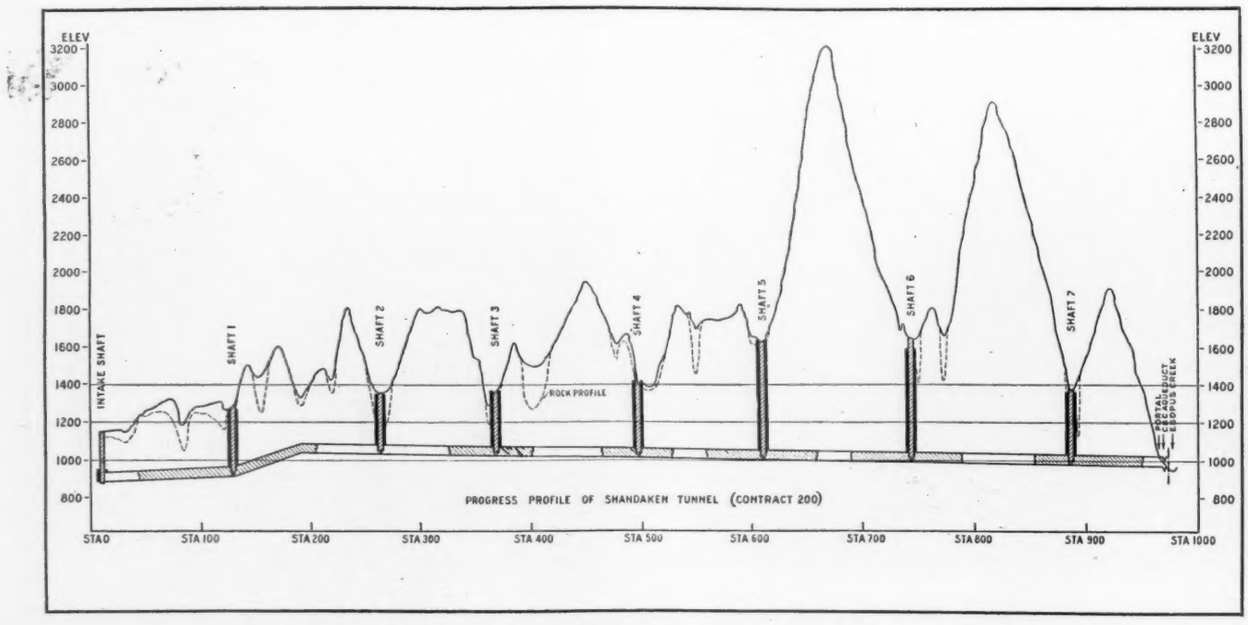
*Six "Leyner" drifters at work at one of the headings before holing through was finally effected.*

This result was in large part due to the great care exercised by the surveyors on the job and by the skill of the men directing the drilling at the headings. The alignment of the tunnel was checked up at each shaft by two No. 8 piano wires which were carried down from the surface. These wires were suspended over two V-notched vertical wheels which could be adjusted horizontally by micrometer screws. Each wire was pendant from its own wheel, and the wires hung just free of the lining of the shaft and a trifle more than eleven feet apart. At the bottom end of each wire was attached a cross-shaped, 40-pound concrete weight which was immersed in a bucket of water to arrest its movement. An interval of ten minutes was allowed for the pendulum to come to rest after the wire had been adjusted for alignment at the surface, where the true position was determined by a transit and by cross bearings between permanent stone monuments located on each side of the shaft head.

From the bottom of the shaft, the line was carried forward in the tunnel by means of brass scales set in the roof. Beneath each scale an instrument platform was hung to enable the surveyors to make their observations and to mark the center line on each of the scales. To fix an alignment point, 24 observations were made with a shifting-head transit. Thus, with the two vertical wires for starting points, and with the horizontal distance between them as a base line, the surveyors were able to prescribe the advance, to set the gradient along which the drillers were to go, and, similarly, to check any deviation from the chosen course. It should be understood that the surveyors carried the line forward as the drilling and the blasting propressed—working always from the base line at the foot of each shaft. In this manner, up hill and down grade, the men at the headings were guided surely to a definite position hidden deep in the rocky bowels of the mountains.

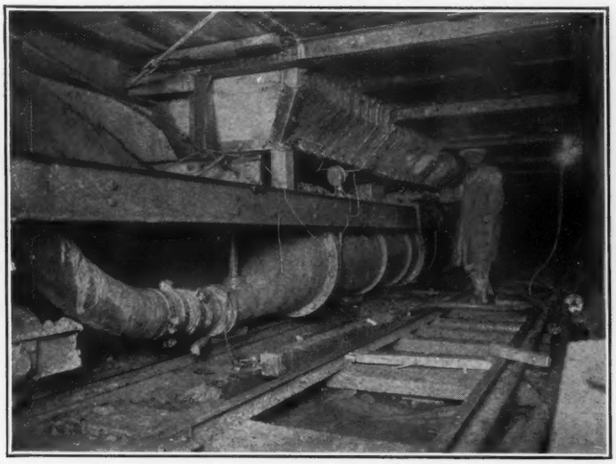
As might be expected, war conditions interfered with the work during the early stages following the awarding of the original contract on November 9, 1917. Since November 10, 1920, when the further prosecution of the work was turned over to the Shandaken Tunnel Corporation, the undertaking has been pushed with all practicable dispatch. It is only fair to the preceding contractor to say that at that time all shafts had been sunk and lined, tunnel headings turned, an electric power line installed above ground over the entire tunnel route, and 11,300 feet of tunnel excavated. During the two years and three months following the date last mentioned, 16 miles of tunnel were drilled and blasted and 7.9 miles of the aqueduct were lined with concrete. The progress made in excavating the tunnel was as follows:

| | Feet |
|---|---|
| Maximum monthly excavation in twelve headings | 5,979 |
| Maximum weekly excavation in twelve headings | 1,430 |

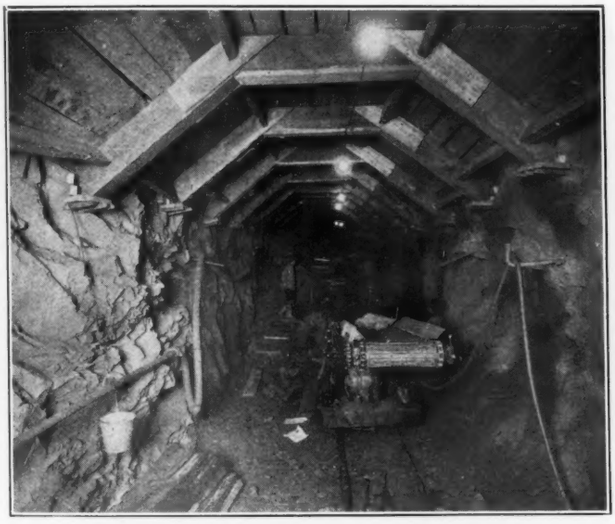



*A contracted, longitudinal section of the region traversed by the Shandaken Tunnel.*

*The car dumps concrete into the depressed hopper at the right of the track whence the material drops into the underlying concrete gun and is forced by compressed air through a large flexible hose which, in this case, is placing the concrete of the arch lining.*



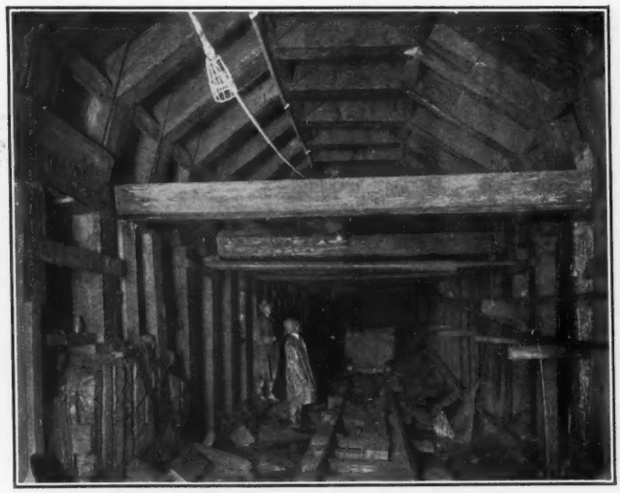
*A view of the concrete gun taken below the tramway platform along which the concrete dump cars travel. The upper receptacle is the hopper which feeds the concrete into the large cylindrical gun from which it is expelled under an air pressure of 50 pounds.*



*At the junction of two headings. A pneumatically operated Meyers-Whaley machine doing the mucking.*

*A section of the tunnel with the side walls of the lining in position ready for the placing of the arch.*

*Blaw-Knox metal forms employed for the placing of the concrete lining of the tunnel arch.*



*Permanent timbered section of tunnel through soft ground at portal near the village of Allaben.*

*Close to a heading in a rock-driven section of the tunnel with an air-driven mucking machine passing the rock rearward and loading it into a waiting car. The pipe at the right of the picture carries numerous taps for compressed air connections.*

*At the bottom of a shaft showing the hopper which receives concrete from above ground through a vertical 8-inch pipe. From the hopper the concrete is discharged into trains of cars drawn by electric tractors.*

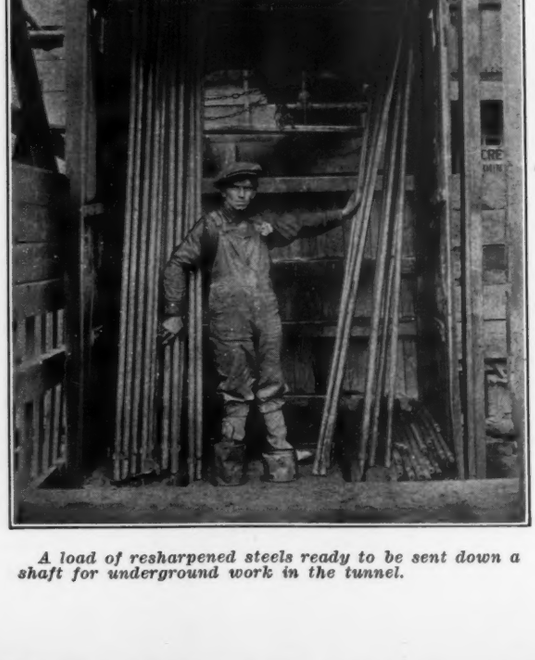
| | |
|---|---|
| Maximum monthly excavation in one heading | 611 |
| Maxium weekly progress of completed tunnel in one heading | 164 |
| Average weekly excavation in all headings | 62 |
| Average weekly progress in all headings after November 10, 1920 | 78 |

The rock through which the tunnel passes is of sedimentary origin, and consists of shale or sandstone of widely varying degrees of hardness. The shales, mostly red, with small amounts of blue and green, drill easily, break well to line, and usually stand satisfactorily for a limited time after exposure; but they have a marked tendency to disintegrate when subjected to atmospheric conditions. The red sandstones are of slightly coarser texture, but are often difficult to distinguish from the shales; almost invariably the two are more or less mixed and, when they have been penetrated in the roof of the tunnel, it has usually been necessary to provide support. The rock beds differ in thickness, and the general dip of the formation is from 1½ to 2 degrees toward the south .

The gray and the blue sandstones, which are the hardest and the coarsest grained of all the rock encountered, are more difficult to drill and shoot, but have the virtue of requiring very little scaling; and, when not too thinly bedded, commonly stand well without support. The phenomenon of "popping rocks" has been frequently evidenced in the gray standstones which, therefore, have called for roof support.

During most of July and August, 1921, the contractor was troubled by popping rock in the tunnel roof throughout a portion of the south heading at Shaft 3. To arrest this, the exposed rock was protected from the atmosphere by a thin coating of concrete. For this purpose a concrete "atomizer" was utilized, and the fluid mortar was sprayed into place by compressed air. The concrete shielded the rock from air slaking, and the results were so satisfactory that no other support was needed.

The type of the tunnel driven from the several headings was altered from time to time during the progress of the work because of changes in the character of the materials encountered. The top-heading method and hand mucking were used for substantially the entire period at Shafts 1, 3, 4, and 5, and at Shaft 7-south; and the full-faced method, with machine mucking, was employed at Shaft 6 and at Shaft 7-north. At the outlet portal, near Allaben, operations involved 600 feet of tunneling through extremely difficult soft ground. In general, the working shifts were so organized as to permit two shots per day in the top-heading tunnels and alternate advances of two shots and one shot per day in the full-faced tunnels. Trimming was carried along closely behind the main excavation throughout a plane one foot above the finished concrete invert elevation. Water "Leyner" drills, mounted on vertical columns, were used in the headings, and "Jackhamers" were relied upon in drilling the benches.



*A load of resharpened steels ready to be sent down a shaft for underground work in the tunnel.*

From May 4, 1921, to February 13, 1923, when the last stretch of rock was holed through, an average weekly progress of 208 linear feet was maintained at the two concluding headings. The excavation quantities for this tunnel have ranged from 6.64 to 7.73 cubic yards per linear foot, while the corresponding concrete quantities averaged between 1.87 to 2.64 cubic yards, respectively, for unsupported and supported types. The total payment quantity of rock excavation is approximately 573,000 cubic yards.

At no time during the prosecution of the job has water from subterranean springs or other sources occasioned serious inconvenience. The inflow of water at several locations has never been so great as to hamper work or to require any but ordinary methods for its control. The maximum and the minimum average inflow per minute occurred at Shafts 1 and 7, and amounted, respectively, to 74 and to 7 gallons.

Transportation of tunnel muck to the shafts has been effected by means of electric-storage-battery locomotives, pulling six or seven end-dump cars, each having a capacity of about a cubic yard of solid rock. The cars have been carried singly on the cages to the tops of the shafts, where they have been pushed by hand to the tipple and dump.

Roof support, whether in the form of permanent or temporary timbering, has been necessary throughout 48.3 per cent of the tunnel's length. Where the timbering has been of a temporary nature this support has been placed within the concrete limits and will be removed before the lining is completed. Five Universal concrete guns are being utilized in placing the arch portion of the tunnel lining—Blaw-Knox metal forms serving to facilitate this work. Concrete has been delivered by these guns a maximum distance of 200 feet. An air pressure ranging from 80 to 100 pounds is generally employed in "shooting" the

| Shaft | Tunnel heading | Length (feet) | Supported lengths (feet) | Elapsed time (weeks) | Average weekly (feet) | Maximum weekly completed tunnel (feet) | Tunnel excavated in rock |
|---|---|---|---|---|---|---|---|
| Intake | South | 16 | 0 | 4 | 4 | 12 | " |
| 1 | North | 11,886 | 1,508 | 152 | 78 | 150 | " |
| 1 | South | 13,357 | 0 | 166 | 80 | 155 | " |
| 2 | North | 33 | 0 | 3 | 11 | 22 | " |
| 2 | South | 709 | 0 | 13 | 60 | 119 | " |
| 3 | North | 9,721 | 1,557 | 115 | 85 | 148 | " |
| 3 | South | 6,664 | 2,677 | 100 | 67 | 151 | " |
| 4 | North | 6,253 | 1,158 | 69 | 91 | 164 | " |
| 4 | South | 4,791 | 1,904 | 53 | 90 | 150 | " |
| 5 | North | 6,407 | 4,745 | 123** | 52 | 138 | " |
| 5 | South | 6,483 | 3,606 | 123** | 53 | 130 | " |
| 6 | North | 6,849 | 6,711 | 128 | 54 | 99 | " |
| 6 | South | 8,333 | 8,330 | 150 | 55 | 114 | " |
| 7 | North | 5,952 | 5,806 | 160** | 37 | 84 | " |
| 7 | South | 7,928 | 1,366 | 162** | 49 | 155 | 7614 ft. rock; 314 ft. earth |
| | Portal North | 220 | 272 | 17 | 13 | 28 | |
| | Totals | 95,602 | 39,640* | 1,538 | 62 | | |
| | After Nov. 10, 1920, | 84,302 | 37,109 | 1,078 | 78 | | |

NOTE.—The foregoing lengths of tunnel between shafts do not include the portions of the tunnel which were excavated as parts of the shafts.
*In addition there was 6,564 feet of temporary support.
**No work for 16 weeks at 5 North.
No work for 23 weeks at 5 South.
No work for 21 weeks at 7 North and South.

concrete. When the gage pressure drops to 25 pounds at the muzzle of the gun, the man in charge knows that the batch has moved onward and cleared the 6-inch flexible hose through which the concrete reaches the point of placing. A charge consists of from 9 to 11 cubic feet of concrete, and this amount about half fills the loading chamber of the gun. The gun has a length of 17 feet 1¼ inches and an internal diameter of 2 feet. The piston stroke is 5 feet 9 inches. The Universal concrete gun is the invention of Webb & Cox of Los Angeles, Cal.

The concrete for the tunnel lining is mixed above ground and delivered thence down the shafts through 8-inch piping which discharges into a hopper at the bottom of each shaft. From the hopper the concrete is dropped into 1-yard cars which, in their turn, are emptied into a hopper immediately connected with the gun. Up to the first of March of the current year, 42,069 linear feet of the tunnel had been concreted. This was equivalent to 44 per cent. of the total lining work which will be done. The maximum rate of concreting per week for the entire contract was until then 1,454 feet.

For the information of the reader who may be interested in details, the tabular statement of excavation progress is printed.

The compressor installation for this great job has been made up of thirteen machines having a combined capacity of 9,325 cubic feet of free air per minute. In addition to operating the drills, "Jackhamers," concrete guns, and muckers, compressed air has been used for the working of six drill-steel sharpeners and a number of Cameron pumps.

The estimated cost of the completed tunnel is $12,138,738; and it is computed that this unique aqueduct will deliver daily from the Schoharie watershed a matter of 300,000,000 gallons. The tunnel will be capable, however, of conveying double that quantity of water from the Schoharie Reservoir whenever rainfall or runoff so permits. A year or more will be needed to finish the lining of the tunnel and to bring to a conclusion operations at the intake shaft and at the portal at the opposite end of this rock-hewn passage. Thus, the Catskill Water Supply System is expanding in anticipation of the steadily growing needs of the millions of dwellers in Greater New York and of the many thousands of transients who frequent the Metropolis daily.

## THE PIN A BIG FACTOR INDUSTRIALLY

SOMETHING like 10,000,000,000 pins, equivalent to 4,000,000 pounds, are manufactured in the United States each year. The industry employs over 10,000 persons, and consumes about 26,000 tons of coal, 2,500 barrels of fuel oil, and 27,000 cubic feet of gas annually. Connecticut is the greatest pin-making state in the country, and produces substantially 85.6 per cent. of the common variety and 45 per cent. of miscellaneous pins and needles. The value of its output is estimated at $14,000,000 every twelvemonth.

In this connection it may be of interest to note that pin-making machines were invented in the United States as far back as 1775. The industry was not entirely successful, however, until the year 1836, when the Howe Manufacturing Company was organized in the Nutmeg State. And this brings us to the question that has so often been put: "What becomes of the thousands of pins used daily?"

## MOVING SIDEWALKS

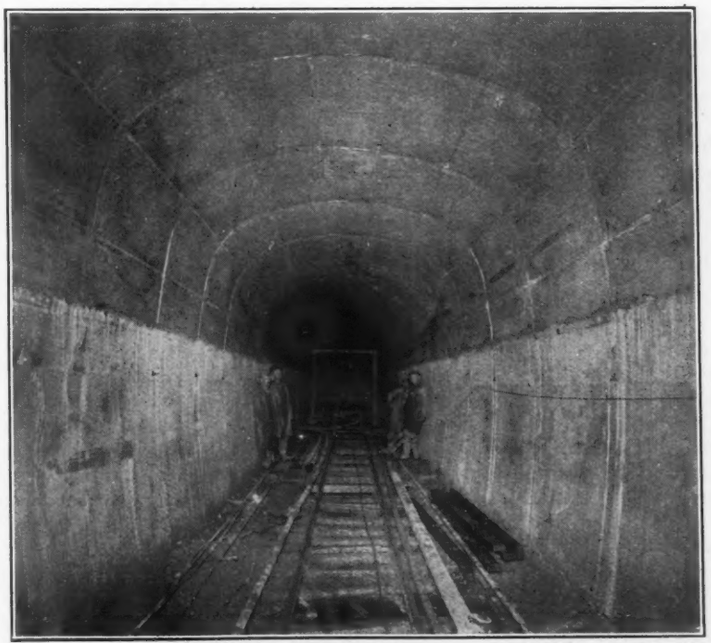
THE City of Paris seems to be seriously considering the installation of a moving sidewalk underground. Thirteen plans have been submitted, and five of these are to be tried experimentally in two groups, representing different ideas, over a circular run of 300 meters.

The plans of the first group are for parallel bands at different speeds, passengers stepping first on the slowest and then on the next until the most rapid is reached. The process for alighting is reversed. The scheme seems to be well adapted for the development of promptness and decision in its patrons; but, in any case, it could be of little value unless running in both directions.

A second plan, which is still less intelligible to us, is based, says *The Engineer*, London, on the idea of variable speed—slow movement at stations and a higher speed between stations. Whether successful or not, it is to be hoped that an adequate trial will be made.

## VAPOR-TIGHT TANKS PREVENT EVAPORATION LOSSES

A VAPOR-TIGHT tank is essential for preventing evaporation losses of oil, states Ludwig Schmidt, junior chemical engineer of the United States Bureau of Mines. Today almost every steel tank manufacturing company is making vapor-tight tanks which are effective when properly equipped and handled. Tanks for this service must be provided with vacuum and pressure relief valves, the two valves frequently being combined in one case. Valves of this type may be divided into four general classes: liquid seal, combination mechanical and liquid seal, mechanical valves other than dead weight, and mechanical dead-weight valves.



*A section of the Shandaken Tunnel with the concrete lining of the sides and arch in place. The invert has still to be lined.*

# Compressed Air Magazine

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*EDITORIALS*

## COMPARATIVE PRICES OF BASIC COMMODITIES

BASIC commodities, such as iron and steel, coal, rubber, wheat, copper, etc., have shown a disposition to rise steadily in price since April, 1922. Official figures of twenty basic commodities in the United States and in England reveal that from April to July, 1922, there was an almost equal and parallel rise in England and in the United States—the advance being greater in the United States than in England.

About the middle of last year, the prices for these products began to fall to a greater extent in the United States than in England—the two lines crossing twice in the middle of 1922. The rise was resumed in the latter part of 1922, continuing in the United States without interruption until about April, 1923, when prices began to go down somewhat. During this same period, the prices in England fell slightly: the rise being resumed around the 1st of January, 1923. The two lines again crossed about April, 1923, at which time the prices in the United States fell while those in England continued to mount until at present they have assumed a level or are practically stationary.

An interesting fact is brought out by these figures, namely, that between the middle of 1922 and April, 1923, the advance in prices of basic commodities was greater in the United States than in England. This same condition of comparison applies to practically every country in the world except Japan, and accounts, in some measure, for the increased imports into the United States in view of the fact that the United States was the best market for sales and the worst market for purchases, as far as prices are concerned.

## OUR RAILROAD STOCKS NO LONGER WATERED

THE FEDERAL valuation of the railroad systems of the United States, which has been in progress for the past ten years, has, as yet, produced no positive, final result. Authorized by Congress, and estimated to cost from $2,000,000 to $3,000,000, something like $75,000,000 has already been spent—of which about $54,000,000 has been supplied by the railroads and the balance by Congressional appropriations. The only tangible result—and this but a semi-tangible one—has been the production of so-called tentative valuations of 38 systems representing approximately a third of the country's mileage.

This doesn't seem like getting ahead very fast, for it must be borne in mind that each of the carriers has the right of protest against the tentative findings. In almost every instance such protests have been filed; and, before final valuations can be determined, each case must be argued before the Interstate Commerce Commission and, on appeal, before the Supreme Court of the United States. In this manner it may be a long time, possibly years, before a final valuation of all the systems is written into history.

The tentative valuations, whatever the outcome be, have already been productive of one good result—worth, perhaps, the entire cost of the work: they have disproved the popular contention that the railroads are enormously over-capitalized. If there ever was any "water" in railroad stocks the tentative valuation of the 38 systems shows that it was long ago squeezed out.

## NEW SHIPS INSTEAD OF OLD ONES RECONDITIONED

THE rehabilitation of the steamship *Leviathan* and the determination of the United States Government to place her in transatlantic service gratify a popular demand that the Stars and Stripes be carried upon a great passenger craft. To add further to our satisfaction, Government experts declare that the reconditioned *Leviathan* is of 5,000 tons greater gross tonnage than when she was known as the *Vaterland* and sailed under the German flag.

If this be so, then the *Leviathan* excels the *Majestic* by 3,405 tons and is, accordingly, the largest of liners. This newer measurement is arrived at, so we are told, by including certain "dead spaces" which are ordinarily not counted by private owners who have the best of reasons for keeping their tonnage rating down so that their port and dock charges may be as low as possible. If the *Leviathan* is smaller than the *Majestic*, as she no doubt is, the advertising advantage of fictitious tonnage will be more than counterbalanced by the tax that will be levied upon the public purse.

Happily, this mistaken policy of parade has been recently offset by the really wise decision of the Shipping Board not to recondition the two former German liners now known as the *Agamemnon* and the *Mount Vernon*. To do this so that they would be fit for passenger service would entail an outlay of $16,000,000. New ships of the same size but of up-to-date construction can be had at an expenditure of $12,000,000 apiece; and their building would give our shipyards something to do and provide employment for thousands of persons. The intention of the Shipping Board is to ask Congress to provide $24,000,000 in the next budget for this purpose.

This subject brings to mind the attitude of the selfsame Board in 1919 when it enthusiastically endorsed the fabrication of two monster transatlantic liners 1,000 feet long and to cost $20,000,000 each. Those boats were to be nautical giants, to have a deadweight capacity each of 60,000 tons; to be driven by turbines aggregating 110,000 H.P.; and to be able to make at full speed 30 knots an hour. That ambitious program was conceived as a means towards giving us the blue ribbon among ocean greyhounds and to appeal to the hundreds of thousands of our people who go abroad yearly and who spend millions for the support of alien lines. Perhaps it would be more judicious for us to build upward in creating a passenger fleet rather than to strive for the palm at one stroke by constructing the biggest things afloat—vessels that are not always economical or profitable to operate.

## IS INDUSTRY PRODUCING MORE PER CAPITA?

THE QUESTION is often asked: "Are we more or less efficient since the war?" Large manufacturing concerns tell us that the output of their works is about equal to the high point in 1919, but that the force employed by them is considerably less.

The Department of Commerce has made some careful investigations on this point and has reached the conclusion that "we are producing a larger amount of commodities per capita than ever before in our history." Mr. HOOVER is responsible for the statement that "exhaustive studies, made from many angles of production over average periods ten years apart before and since the war, indicate that while our productivity should have increased about 15 per cent., due to the increase in population, yet the actual increase has been from 25 to 30 per cent."

If this condition of industrial vigor exists and such would seem to be the case, it has been brought about by numerous causes—among them increased skill of the workers, and advancement in mechanical aids such as labor-saving devices. It is likely that some of the improvement may be laid to temperance. Mr. HOOVER gives as the primary causes the great stride made in industrial administration and in commercial organization, and the elimination of waste in both effort and material. Progress in this direction not only augments profits and adds to the wealth of the country but it helps to increase wages and to raise the standard of living of all the people.

## LEST WE FORGET

INDEPENDENCE DAY, the Fourth of July, still persists ostensibly as an excuse for firecrackers, picnics, and other forms of diversion lacking anything of a reminder of that momentous occasion, 147 years ago, when the signers of the Declaration of Independence decided to "hang together lest they be hanged separately."

It is a regrettable fact that the populace at large is prone to be forgetful of the circumstances and the sacrifices associated with every trying period of our national history. Our citizenry, much like other peoples, is apt to live only in the present and to be but fleetingly heedful of the men and the National acts which have made this country the prosperous and the secure home of more than 100,000,000 persons. After well-nigh every war there has been propaganda against the perpetuation of our armed forces—a belief prevailing widely that there would be no more strife and, therefore, no more need of the army and the navy.

Undoubtedly, all of us desire perpetual peace; but, alas, harmony among nations is no more assured from now on than the continual observance of law and order in any considerable community where conflicting interests inevitably exist. We can, at best, do no more than hope that the future will find the nations of the world less inclined to rush into conflict than in the past; but we should err grievously if we failed to recognize that a show of strength is always a measurable safeguard against affront and attack. And the lack of this reserve of power may cost dearly.

From Washington our army statisticians have recently sent broadcast figures which disclose that the Central Powers, with a total mobilization of 22,850,000 soldiers, occasioned 22,090,000 casualities among the fighting men of the Allies who numbered 42,189,444, while the latter force was able to cause but 15,405,000 casualties among the enemy troops. In other words, the War Department chart shows that per 1,000 mobilized, the Central Powers inflicted 966 casualties as against their opponents' 365. What does this mean?

The explanation is that the German and the Austrian armies were produced under a system of universal military training while the Allied and associated forces, with the exception of the French army, had no such background. As we are told, "the great mass of soldiers of the Central Powers had been trained and equipped prior to the outbreak of the war while the soldiers of the Allied and associate powers were, to a great extent, hastily trained and equipped after the outbreak of war."

Our military experts are convinced that the figures mentioned warrant the contention that careful training, especially of officers both for duty with company commands and for staff work, assures a reduction in the price that otherwise must be paid in dead, in wounded, and in the sick of any large military operation. If such be the case, can we afford to be forgetful? Would it be wise for us to neglect to maintain our defensive arms and to permit them to reach a state that would render them incapable of forming an efficient nucleus about which ample organizations could be quickly mustered in time of need?

Mr. JOHN W. WEEKS, Secretary of War, declares that our army is today too small; and the Secretary of the Navy, EDWIN DENBY, is equally sure that the navy should be kept in a state of readiness because, as he expresses it, "the world is full of menace." It is the unexpected that happens; and comparatively few of us can recite the many times we have been called upon since 1775 to resort to arms. The accompanying list tells its own story; and if the record of the past means anything it is a warning in behalf of preparedness.

1775. The Revolution.
1782. Wyoming Valley insurrection.
1786. Shay's rebellion.
1790. Northwest Indian War.
1791. Whisky insurrection.
1798. War with France.
1799. Fries's rebellion.
1801. Tripolitan War.
1806. Burr conspiracy.
1806. Sabine expedition.
1807. Chesapeake Bay affair.
1808. Lake Champlain affair.
1811. Northwest Indian War.
1812. Great Britain.
1812. Seminole War.
1813. Peoria Indians.
1813. Creek Indians.
1817. Second Seminole.
1819. Yellowstone expedition.
1823. Blackfeet Indians.
1827. Lefevre Indian War.
1831. Sac and Fox Indians.
1832. Blackhawk War.
1832. South Carolina nullification.
1833. Cherokee War.
1834. Pawnee Indians.
1835. Third Seminole.
1836. Second Creek Indians.
1837. Osage Indians.
1838. Heatherly Indian War.
1838. Mormons.
1838. New York–Canada frontier.
1846. Doniphan's Mexican expedition.
1846. Mexican War.
1846. New Mexican expedition.
1848. Cayuse War.
1849. Navajo.
1849. Comanche Indians.
1850. Pitt River expedition (California).
1851. Yuma expedition.
1851. Utah Indian.
1851. Oregon and Washington Indians.
1855. Snake Indians.
1855. Sioux Indians.
1855. Yakima expedition.
1855. Cheyenne Indian.
1855. Florida War (Seminoles).
1856. Kansas border troubles.
1857. Gila expedition.
1857. Sioux Indians.
1857. Mountain Meadow Massacre.
1857. Utah expedition.
1858. Northern Indian expedition.
1858. Puget Sound expedition.
1858. Spokane Indian troubles.
1858. Navajo expedition.
1858. Wichita expedition.
1859. Colorado River expedition.
1859. Pecos expedition.
1859. Antelope Hills expedition.
1859. Bear River expedition.
1859. San Juan imbroglio.
1859. John Brown raid.
1859. Cortina troubles.
1860. Pah Ute expedition.
1860. Kiowa and Comanche Indians.
1860. Carson Valley expedition.
1860. Navajo expedition.
1861. Apache Indians.
1861. Civil War.
1862. Indian Massacres (Minn.).
1862. Sioux Indians.
1863. Cheyenne War.
1865. Northwestern Indian War.
1865. Fenian raid.
1867. Mexican Border Indian War.
1868. Canadian River expedition.
1871. Yellowstone expedition.
1871. Fenian troubles.
1872. Yellowstone expedition.
1872. Modoc campaign.
1873. Yellowstone expedition.
1874. Indian Territory War.
1874. Sioux War.
1874. Black Hills War.
1875. Nevada expedition.
1876. Sioux War.
1876. Power River expedition.
1876. Big Horn expedition.
1876. Sioux War.
1877. Nez Perces campaign.
1878. Ute campaign.
1878. Snake Indian.
1890. Sioux.
1891. Mexican Border (Tin Horn War).
1895. Bannock Indian trouble.
1898. Spanish American War.
1898. Chippewa Indians.
1899. Philippine insurrection.
1900. Boxer insurrection.
1912. Nicaraguan expedition.
1913. Haitian and San Domingo.
1914. Vera Cruz.
1916. Punitive expedition in Mexico.
1917. Germany.

© Military Engineer.

Let us keep before us the splendid work done by the men of the army and the navy in scores of directions which bears directly upon the joys of peace and upon progress in engineering, in science, and in many other departments of worth-while human effort. To this end, we are tempted to recall an address made last November by Mr. WEEKS, in which he stressed the average citizen's unfamiliarity with the work of the army. With reasonable pride he pointed out the pioneer achievements of our army surgeons; the great constructive tasks carried to completion by the army's corps of engineers; what the army has done in developing Alaska, in colonizing the Philippines, Hawaii, Cuba, Porto Rico, and Panama; the relief work abroad aided by men of the army; the army's part in promoting aviation; its monumental accomplishments in the field of wireless communication; its active share, with the navy, in starting the steel industry in America; and, among other things, what the army did in blazing the way for standardization and the creation of a system of interchangeable mechanical parts.

Proud as we are of the brilliant deeds of our fighting fleet in times of war, still we have equal reason for pride in what the men of the navy have done throughout the much longer periods of peace. Besides playing the part of ambassadors in the promotion of friendly relations throughout the world since the days when the service was first organized, advancing the while our maritime interests abroad, the officers of the fleet have been instrumental in bringing home to us and to other peoples a fuller knowledge of all the navigable seas and the coasts that can be reached by the intrepid mariner. Naval men have aided in blazing the way in unfamiliar lands; and it is common knowledge how they penetrated far into the Frozen North and finally placed the Stars and Stripes at the North Pole. In astronomy, in meteorology, in oceanography, in hydrography the names of American naval officers are conspicuous. In engineering, in mathematics, in various fields of science, and in the realm of invention, the personnel of the navy has contributed generously. In fact, the navy's leadership in the construction of steel craft made it possible for us to develop our shipbuilding industry as we have it today. Not only that, but the navy in doing this inspired and supported to a stage of self-sufficiency scores of manufacturing endeavors that have strengthened us and benefited the nation incalculably.

This was strikingly emphasized when our shops and factories were suddenly called upon in 1914 not only to turn out products to their capacities but to undertake the making of manifold unfamiliar articles. Then it was that men still in the army and the navy and others trained for those services, but no longer in them, came forward and enabled us to do a wonder work. Executives and experts for that period of anxiety would have been lacking or slow in developing but for the leadership of the men mentioned.

West Point and the Naval Academy, as technical institutions, and the other service schools, both for the rank and the file, have long added not only to our defensive capacity but to the administrative and to the productive qualifications of thousands of men intimately associated with the civil and the peacetime activities of the United States.

Don't let us forget these facts. Our military organizations are safeguards of peace; and if our independence, born on the Fourth of July, 1776, means to us now what it did to our forefathers, every patriotic impulse should prompt us to make certain of a reasonable measure of preparedness.

## WHY INVITE DISASTER

VARIOUS BUILDERS of air compressors are continually urging users of their machinery to pay particular attention to the erection and to the maintenance of such equipment. No small measure of time and money has been spent in the preparation of comprehensive instruction books, copies of which are sent with the compressor when the machine is shipped to the purchaser.

The latest of these instruction books are profusely illustrated and expressed in terms which any operator can readily understand. The best examples of these pamphlets go into details and tell exactly how and where to erect a compressor; how to lubricate and to take care of the machine while it is operating; when and where to inspect it; and how to make necessary adjustments and repairs. Further, the materials employed in the making of each part are specified.

The instruction books amply justify themselves, because the manufacturer is more than repaid through the better care which his machine receives owing to the better understanding of the operating engineer. But there are still many cases which prove that the operator has not seen or, perhaps, has never read the instruction book covering the machine for which he is responsible, and, as a result, there is apt to be a hurry call for repair parts. Then, there is the case where the compressor is fully understood but where the piping associated with it is incorrectly installed. The importance of proper piping is appreciated by manufacturers of compressors, and most instruction books are specific in pointing out the right and the wrong way to arrange the piping.

A good example of what may happen when due regard is not given to this matter is afforded by the recent experience of a compressor user. The unit in question was set up all right but the connection with the air receiver was faulty in that a valve was placed in the line between the compressor and that tank, and no one realized that a safety valve should have been provided in the line between the compressor discharge and the valve in question.

Quite unconscious of the lurking danger, the man in charge started up the compressor with the valve closed, so that an excessively high pressure was consequently built up almost immediately. The result was disastrous: the top of the high-pressure cylinder was blown off, taking with it the discharge pipe and the incorrectly placed valve. Further, the front end of the compressor frame was broken, destroying the main bearing jaws, and, as a consequence, the flywheel was let loose and smashed into many pieces. As an observer remarked: "The machine was a complete wreck. That no one was injured is still a mystery."

The question of correct piping between a compressor discharge and an air receiver is one which comes up at fairly frequent intervals; and COMPRESSED AIR MAGAZINE believes that the following extract, taken from an instruction book issued recently by one of the leading manufacturers, may appropriately bear repeating here in the hope that it may aid in reducing accidents of the sort in question:

"The air receiver or tank should be placed as close to the compressor as possible so as to keep the discharge pipe short. Unless absolutely necessary, a stop or check valve should not be placed in the air line between the compressor and the receiver. If such a valve is placed between the compressor and the receiver be sure that a safety valve is installed between this stop or check valve and the compressor discharge. This is necessary, as there is always a possibility of starting up the compressor with the stop or check valve closed, in which case, as the air cannot escape, an explosion will result.

"If the compressor is to be connected into an air main common with other compressors, see that a safety valve is placed between the compressor discharge and the first valve in the air line."

## WHO NEXT AN ENGINEER?

THE FOLLOWING verses by James J. Montague, which appeared in the New York Tribune, are to the point and suggestive, inasmuch as the editorial offices of this Magazine have recently been proffered the services of a scribe in Central Europe who describes himself as a "literary engineer!"

No longer little Micky Hare,
  Whose ways are mild and meek,
Will keep my clothing in repair
  For 50 cents a week.
He now demands a larger sum
  Which I esteem too dear
For lately Michael has become
  A Pressing Engineer.

The days when Tonio Dorio
  Would clip and trim my lawn,
And make my kitchen garden grow,
  For ten a month are gone.
He now is making wads of pelf,
  Takes contracts by the year,
And on his billheads styles himself
  A Mowing Engineer.

The lads from Greece who cleaned my shoes,
  Once in a cheaper time,
Now with a haughty scowl refuse
  My little proffered dime.
One sees them by appointment now,
  They're risen, it appears,
And have become, so they avow,
  Shoe Surface Engineers.

Old 'Rastus Johnson comes no more
  To take the cans away,
Or knocks upon the kitchen door
  To seek his weekly pay.
He found a means of getting his—
  The dusky profiteer—
His card informs me that he is
  A Garbage Engineer.

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The latest available returns show the Philippine Islands to have a total population of slightly over 10,000,000.

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Coal-cutting machines are among the most widely used of mining equipment. Practically all of these machines are operated either by compressed air or by electricity.

DISCOVERIES AND INVENTIONS OF THE TWENTIETH CENTURY, by Edward Cressy. A volume of 458 pages with numerous illustrations. Published by E. P. Dutton & Company, New York. Price $5.

THE PRESENT work is a second and enlarged edition of a book brought out in 1914, and has been largely inspired by the intense activity in discovery and invention which occurred during the four years of the World War. Mr. Cressy has done an admirable thing in bringing his earlier effort up to date; and he has dealt with the various topics under discussion in a plain and illuminating fashion. All too many of us are unalive to the enormous strides that have been made in the mechanic arts, in chemistry, in engineering, and in other fields of human endeavor in the course of the past twenty-odd years. Anyone should be more appreciative of this onward march of civilization and man's ever-increasing mastery of the things that make for a fuller and more effective life by reading Mr. Cressy's book.

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SEABORNE TRADE, by C. Ernest Fayle. This work is Volume II. of a History of the Great War based on official documents and compiled by direction of the Historical Section of the Committee of Imperial Defense. It is a book of 424 pages, with suitable maps, published by Longmans, Green & Company, New York. Price $7.50.

THIS BOOK covers the history of seaborne trade from the outbreak of the submarine campaign against merchant shipping, in February 1915, to the appointment of the Shipping Controller in December, 1916. It is a record both of the effect of the submarine campaign on seaborne trade and of the measures taken to maintain the flow of essential supplies. This able presentation of a vital topic makes it vividly clear how prime a part merchant shipping played in the prosecution of that world-disturbing conflict. No student of maritime affairs, no one that wishes to know how essential a merchant fleet is to a nation, should neglect to acquaint himself with this product of Mr. Fayle's pen.

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THE MAKING OF INDEX NUMBERS, by Irving Fisher, Professor of Political Economy, Yale University. A volume of 526 pages, published by Houghton Mifflin Company, Boston and New York. Price $7.50.

IN THE prefatory note to this book, we read: "All sciences are characterized by a close approach to exact measurement. How many of them could have made much progress without units of measurement, generally understood and accepted, it is difficult to imagine. In order to determine the pressure of steam we do not take a popular vote: we consult a gauge. Concerning a patient's temperature, we do not ask for anybody's opinion: we read a thermometer. In economics, however, as in education, though the need for quantitative measurement is as great as in physics or in medicine, we have been guided in the past

largely by opinions and guesses. In the future, we must substitute measurement for guesswork. Toward this end, we must first agree upon instruments of measurement. To the Pollak Foundation for Economic Research it seems fitting, therefore, that its first publication should be The Making of Index Numbers."

Following out this idea, Professor Fisher discusses index numbers, shows how they can be arrived at, and explains the numerous and various uses to which they can be put in evaluating sales prices, the trend of industry, the likelihood of "hard times" and "good times," and generally establishing satisfactory cost or economic bases of comparison. The work is suitable as a textbook for business and university statisticians, for engineers, and, in short, for anybody who wants to be informed.

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INTELLIGENCE MEASUREMENT, by S. C. Kohs, Ph.D., Professor of Psychology, Portland Center, University of Oregon. A work of 312 pages, with numerous graphs and tables, published by The Macmillan Company, New York. Price $3.

THE PURPOSE of this contribution to psychology is to enable the investigator to evaluate a person by what the subject does rather than by what he says, and to this end recourse is had to a series of block-design tests.

As the author says: "The special value of the block-design tests lies in the fact that valid results may be obtained independently of the 'language factor.' Neither deafness nor lack of language-understanding should be disqualifications in the proper performance of the test. The block designs may therefore be utilized in the study of racial differences, in determining the mental capacities of the deaf and of those suffering from various other language handicaps." It would seem that this system might be used to advantage in determining the intelligence weights of immigrants coming to us ignorant of our tongue and, perhaps, possessed of only a limited vocabulary in their native languages.

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INTERVIEWS WITH MINING ENGINEERS, by T. A. Rickard, formerly editor of the Engineering & Mining Journal, The Mining Magazine, and the Mining & Scientific Press. A volume of 552 pages, with illustrations. Published by Mining & Scientific Press, San Francisco.

FOR YEARS Mr. Rickard has been an outstanding and heartening figure in his special field as a writer and an editor, and because of this he has been privileged to interview and to report his talks with men who have shone and still shine in the realm of mining engineering. Knowing how much the present-day wealth of this nation of ours hinges upon the riches which are withdrawn from the bowels of the earth, and being more or less aware of the difficulties encountered in tapping Nature's underground resources, Mr. Rickard's collection of interviews with 23 leaders of the profession presents a striking and a comprehensive story of mining in America during the last half hundred years. The book, besides being intensely interesting and unusually well written, contains a great deal of valuable information.

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The Erie Steam Shovel Company has recently issued a booklet entitled, Erie Lubricated Caterpillar Type Mounting. The pamphlet explains why the lubricating system adopted and the bushing of the link-pin bearings have made it possible for the Erie caterpillar type of steam shovel to save its users many thousands of dollars. Copies of this bulletin can be had gratis by applying to the company at Erie, Pa.

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## EVALUATING PROPERTIES OF ANHYDROUS AMMONIA

SEVERAL years ago, at the request of the refrigeration industry, the United States Bureau of Standards undertook an extensive investigation of the properties of anhydrous ammonia for the purpose of compiling accurate tables for the use of engineers in designing and in studying the operation of refrigerating machines. All the properties necessary for this compilation have now been determined within the ranges of pressure and temperature ordinarily encountered in practice. The most refined physical measurements have little real value, however, unless assurance is given that the material used is of high purity. The necessary information on this point may be obtained from Scientific Paper No. 465 on the "Composition, Purification, and Certain Constants of Ammonia" which has just been published by the Bureau of Standards.

Analyses of a number of standard American brands of commercial ammonia now upon the market indicate that they are more worthy of the designation "chemically pure" than many of the more common chemical reagents. Tests showed that most commercial ammonias contain less than 0.1 per cent. of impurities.

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## WELDING LONG PIPE LINES

THE annual meeting of the American Welding Society, New York, was of unusual interest, and much valuable information as to up-to-date operations was presented. The matter probably of greatest interest to our readers related to the welding of long lines of steel piping without the use of belts, rivets, or couplings of any type.

Mr. G. O. Carter gave the details of the welding, by the Prairie Pipe Line Company, of a 140-mile line of 8-inch piping, which has been in service for a year. There are three intermediate pumping stations, and the line, carrying 750 pounds oil pressure, has been welded into a continuous tube between the stations. Various other examples of welding upon an extensive scale were cited, and these covered not only pipe lines but also large tanks, barrels for concrete mixing machines, and other equipment. Several successful steam-line installations were referred to, including those of the Warren Iron & Steel Company, Warren, Ohio, and of the American Can Company's plant at Cincinnati. No long compressed air lines were mentioned but they may now be confidently expected.

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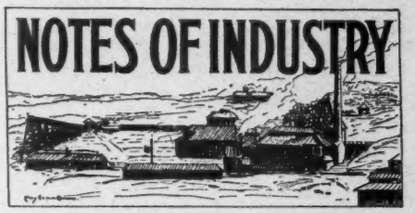
"Bristol Cherub" is a name which has been given to a small aircraft engine recently brought out in England. It is of the double-cylinder, opposed type, weighs about 85 pounds, and is rated at 18 H.P. It is suggested that it may be used experimentally, at least, in developing the possibilities of gliders. Equipped with one of these little engines, to help when the wind fails, it might be made possible for a 'plane to glide over long distances.




The provision business in Havana, Cuba, is likely to be stimulated by the completion recently of three cold-storage houses having a total capacity of 190,000 cubic feet. Freer distribution of perishable foodstuffs from the United States has heretofore been greatly hindered owing to an almost total lack of refrigerating facilities.

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The production of secondary metals from the nation's junk pile in 1922 amounted to 605,882 short tons of copper, lead, zinc, aluminum, nickel, etc., most of which was recovered in the form of pure metal.

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Road-building activity in the State of Michigan for 1923, including state, trunk-line and Federal-aid roads and trunk-line bridges, will involve a stretch of 978 miles and reach an estimated cost of $16,253,194.

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The annual convention of the National Association of Practical Refrigerating Engineers is to be held this year at Memphis, Tenn., from December 12 to 16, inclusive.

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According to the figures compiled by the Department of Commerce there were exported in February of this year 1,763 portable pneumatic tools, valued at $32,897, as against 278 in February of 1922 worth $21,242.

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It is conservatively estimated that eastern Nicaragua will produce 17,000,000 feet of mahogany this year; and that all the wood contracted for has been taken by eight American companies. The cutting of mahogany has been carried on in this district for over 70 years. At the beginning of the industry, the trees were located close to the main rivers, but as the cutting continued the contractors were forced to proceed further inland. Wood is now brought from a distance of over 200 miles up the Prinzapolka River while still greater stretches are reached by way of the Wanks River, which forms the boundary line between Nicaragua and Costa Rica.

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An agreement relating to the establishment of a free zone at Saloniki has been reached between the governments of Greece and Yugoslavia. This gives Yugoslavia an outlet on the Aegean Sea.

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The highest bridge in the United States, 326 feet above low-water level, crosses the Pecos River 50 miles west of Del Rio, Tex. When the bridge was built, in 1892, there were but two higher ones in the world—one in Bolivia and one in France. Since then two higher spans have been erected in Africa, making the Pecos bridge the fifth in height in the world.

The world production of raw sugar for 1922-1923 is estimated at 18,308,000 long tons. As the total consumption is 19,000,000 tons annually there is actually less sugar produced than is normally required. Furthermore, the 1922 carry-over amounts to but 476,000 tons, and is not enough to meet the shortage. There seems to be but one solution to the problem, and that is to grow more sugar cane and sugar beets.

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Tea, the ancient beverage of the Chinese, is threatened by a formidable rival from the Occident. The use of condensed milk is steadily growing in the Swatow district, although excellent fresh milk, containing a high percentage of butter fat, is available from the water buffalo and other cattle. These animals are kept in considerable numbers by the farmers for draft purposes. The Chinese make no use of the milk from this source on their tables nor do they use it in cooking; but sweetened condensed milk, diluted with hot water, has become popular.

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Since gold was discovered in Australia in 1849-1850, the value of the total production has amounted to approximately $3,131,000,000.

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As an aid in preventing collisions, the State of Nevada is painting a black center stripe on all its concrete pavements. They are doing the same in Michigan—some of the counties boasting a compressed air machine, mounted on a Ford truck, which does the painting by the spray method.

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There are 80,000,000 sheep in Australia. Just think, a flock of fourteen for every man, woman, and child in that commonwealth.

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The State of Sonora, Mexico, is one of the principal producers of graphite.

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## RUTGERS COLLEGE SELECTED FOR MINING EXPERIMENTS

RUTGERS College, New Brunswick, N. J., has been designated by the Secretary of the Interior as a new mining experiment station of the United States Bureau of Mines, and is to specialize in the production and the utilization of the non-metallic minerals. Of these, not mentioning coal, there is a formidable list; and the value of the annual output amounts to almost $1,000,000,000.

The list includes bauxite, cement, clay, feldspar, fuller's earth, graphite, gypsum, lime, mica, phosphate rock, salt, sand and gravel, sand-lime brick, slate, slatestone, sulphur, mineral paints, garnet, asbestos, and talc. The choice of Rutgers was largely due to its location—the college being most centrally situated in relation to both the points of production and utilization of the minerals to be studied.

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Stocking a pond or a stream with fish is a common occurrence, but now New Zealand, in the hope of founding a future canning industry, is stocking the South Pacific Ocean with Atlantic, Sockeye, and Quinnat salmon.

## POWER RESOURCES OF SALMON AND SNAKE RIVERS

TO DETERMINE the power available on the Salmon and the Snake Rivers, Idaho, engineers of the United States Geological Survey made exploratory trips down sections of those streams, and the results of the investigations are now available. In 1921, a party, under the direction of W. G. Hoyt, a hydraulic engineer, made the famous one-way journey down the Salmon River from Salmon to Lewiston. The Salmon is known as the "River of No Return," because the waterway is navigable only down stream and the boat used is either sold or abandoned when the destination is reached.

Salmon River is the largest tributary of the Snake. It rises in south-central Idaho, flows east, north, west, northwest, and south, across the central part of the state, and discharges into Snake River about 50 miles up stream from Lewiston. It drains an area of 14,000 square miles in Idaho, and with the Snake River drains two-thirds of the state. For the greater part of its course below the town of Salmon the river flows through a narrow, almost inaccessible valley, bounded by high granite ranges and having few roads or trails. Along the upper stretches of the river the slopes are well watered and timbered. The flow of the river is well sustained, and the average fall is great, being over fifteen feet a mile for some 50-mile stretches. The walls of the valley are generally of massive granite and afford numerous good sites for dams.

The Geological Survey report contains maps and descriptions of 23 sites at which, it is estimated, nearly 400,000 H.P. could be developed at periods of low-water flow and almost twice that amount at times of medium flow. A project suggested for one of these sites contemplates the diversion of the flow of the Salmon River into the Snake by means of a tunnel eight miles long, which would create a head of 430 feet. Power is already generated on some of the tributaries of the Salmon. The Salmon River Light & Power Company operates a plant at Salmon to supply energy for public utilities and mining; and at Whitebird a small plant is used to furnish current for lighting the village.

The study of the power resources of Snake River were begun in 1920 by an examination of the river between Huntington, Ore., and Lewiston, Idaho, and were continued in 1921 by a similar examination of the river in southern Idaho, between Milner and Weiser.

In its western course Snake River has cut through the basalt and the stratified sediments that make up the extensive plains bordering the river, and between Milner and Weiser it has a total fall of nearly 2,000 feet. Of this drop 340 feet is concentrated at two points —at Twin Falls, where the fall is 140 feet, and at Shoshone Falls, where it is 200 feet. At high stages of the river both these falls compare favorably in grandeur with Niagara. Shoshone Falls is now utilized for the development of power, but Twin Falls, and many other places are valuable potential power sites.

Prior to 1884, when the main line of the Oregon Short Line Railroad was completed across southern Idaho, the Snake River plain from Pocatello westward was a sagebrush desert. Boise had a population of about 50, and other points at which there are now large cities or villages were little more than stage stations. By 1890 the total population of the plain was perhaps 15,000, and a small amount of land was being irrigated. About 1900 the country began to realize that desert lands could be reclaimed by irrigation, and between 1900 and 1910 many extensive Government and private irrigation systems were put into operation in southern Idaho and in other western states. Tracts in southern Idaho amounting to more than 1,200,000 acres are now being irrigated. With the growth of population that followed the opening of these vast tracts there came naturally a demand for power. The first developments were small and were under local control, but now the Idaho Power Company owns and operates practically all the hydroelectric plants in southern Idaho along Snake River, where over 70,000 H.P. is being made available for use. The Government report in question contains maps and descriptive data of nineteen sites, at which 250,000 H.P. could probably be developed even during times of low-water flow.

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## WELDING A BIG GAS HOLDER

WELDING iron or steel by the two or three different means now available is quite frequently and very successfully superseding riveting, and examples of the practice, with air receivers and air piping in mind, cannot fail to interest our readers.

Electric welding was recently employed in the reconstruction of a gas holder in England. The original holder—which was 200 feet in diameter, more than 100 feet high, and had a capacity of 3,000,000 cubic feet—had been destroyed by fire, while the brick tank, 36 feet deep, was but little injured. All the sheets of the three lifts, ranging from 191 feet 6 inches to 197 feet 6 inches, were connected by welding, and the Z-shaped stiffener stays on the inside of the upper lift were also attached by the same means.

It is reported that while the holder contains more than twenty miles of welded joints only two or three small leaks were detected on test. The speed with which the welding was done is given as fifteen feet per hour on overhead and horizontal fillets and twelve feet per hour on the vertical. It was estimated that the time to do the entire job was less than one-half that which would have been required for riveting.

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## EARLIEST PRODUCTION OF STEEL IN AMERICA

The first steel produced in the United States, according to the Geological Survey, was probably made in Connecticut in 1728 by Samuel Higley and Joseph Dewey. Crucible steel was first successfully turned out here in 1832 at the works of William and John H. Garrard, Cincinnati, Ohio. Bessemer steel was first made in this country in September, 1864, by William Durfee, at an experimental plant at Wyandotte, Mich., and open-hearth steel was also first manufactured in 1864 by the New Jersey Steel & Iron Company, Trenton, N. J.